Corporate diversification: a real options approach

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Abstract

We develop a real-options, capabilities-based model to analyze the corporate diversification decision, as well as determine the optimal timing and distance of investment. We expand the model to include the optimization of investment size. Our model predicts that opportunities, synergies, and the uncertainty over a firm's relative capabilities determine the optimal scope, size and timing of investment consistent with some of the existing empirical evidence. In line with previous literature, uncertainty delays investment and increases investment size, as well as decreasing the cognitive distance at which firms will diversify. We empirically test some of this implications, and obtain support for our predictions.

Keywords: Real Options, Corporate Diversification, Resource-Based View
JEL codes: L25; D81; G31

Chapter 1

Introduction

> Our company has indeed stumbled onto some of its new products. But never forget that you can only stumble if you are moving.
>
> Richard Carlton ex CEO 3M, 1950

One of the most important decisions companies are confronted with, once their core segment reaches a certain size and maturity, is to (re)determine their scale and scope, and decide whether to diversify or remain focused on its current sector, running the risk of possibly being left behind or surpassed by competition if the company becomes stagnant. This is a very complex decision, whose success is, in many cases, noisy and hard to measure, and depends not only on the correct understanding of market tendencies, but also on the firms capacity to enforce the strategy efficiently, identify competitive advantages, and explore them, which can be an incredibly difficult task in the current competitive, and fast-changed markets, particularly when entering new growing industries, as is often the case. It is not surprising that as such, corporate diversification as long been established as a central, but controversial topic in the financial and strategic management literature, with multiple theoretical views arising over the years, and conflicting empirical evidence Palich et al. (2000)

The subject first raised considerable scholar attention, in the beginning of the second half of the past century, with the rise of conglomerates in the US and in Europe. So much so, that 63% of the Fortune 500 industrial companies in 1974, generated more than a quarter of their revenue, from diversified activities, up from 30% in 1950. (Rumelt, 1974) . From the 1980s forward, big conglomerates were broken up and corporate diversification, particularly unrelated diversification, was largely seen as inefficient, as doubts grew regarding managerial motives and capabilities to manage several businesses at once. Nowadays only a few of those conglomerates remain, who have been able to maintain a successful diversification strategy over the past years, such as General Electric and 3M.

However, corporate diversification is not only relevant for big conglomerates, but an important component in the strategy of every firm. It is hard to imagine what Apple be today if it was still just Apple Computers. Nevertheless, not all firms

are successful, and able to derive real value from diversifying. An online survey McKinsey (2015) conducted in 2014, found three-quarters of respondents companies have pursued at least one business activity in a new category, over the previous five years, while another 14 percent of companies have either considered doing so or plan to do so in the next five years, which amounts to almost 9 in every 10 companies. The capacity to access new profit pools (secure long-term growth outside the core segment, or diversify risk exposure to the core segments business cycles) and to strengthen the core business (acquiring skills or technology that are lacking in the core business, or secure competitive advantages for the core business), were the main motives presented for diversification, but only 28% of respondents say this move has created significant value. Few executives consider their companies follow the best practices that make diversification successful, and most often consider their company struggle to scan for new opportunities, evaluate those opportunities, and integrate new activities into the core business. Those who do so, for each of those three steps, are around 2 times more likely to report creating significant value. Particularly, both those who report having a clear strategy for expanding, and those who actively review performance, are 4 times more likely to have generated significant value, to those who dont.

Given this differences in performance, and the mixed empirical evidence, it is not surprising managers have very little academic insights to rely on, when deciding on whether to diversify, and mostly rely on instinct, as there is a lack of suitable mathematical theoretical models which can be used to aid these decisions, or at least force them to make explicit assumptions, that incorporate capabilities and the true way managers reason on these issues. Furthermore, the link between industry diversity, wealth and growth Hausmann et al. (2014), and inequality Hartmann et al. (2017), has been shown in recent literature, which justifies policy makers interest in diversification. Our goal is to determine the optimal distance, timing and scale for a diversification investment, drawing from insight from the Resource-Based View (RBV) and Dynamic Capabilities Approach (DCA), depending on the external (uncertainty and opportunities) and internal (resources and capabilities) context of the firm, to answer questions such as, do more (or less) capable firms move quicker into closely related (or little related) businesses? How much should a firm invest to maximize its benefits from diversification? How does uncertainty affect the value of diversification opportunities?

We will do so by developing a real options model that reflects how the firms resources and capabilities to seize opportunities, affect diversification decisions in a context of uncertainty, incorporating a network-based view of relatedness which stems from recent research such as the product space , first introduced in Hidalgo et al. (2007), at a macro level, and develop in subsequent work. Real options are becoming increasingly influential in strategic management, providing useful insights into investment decisions Trigeorgis & Reuer (2017). In this decision, we can identify the main conditions which make a real options approach particularly useful: uncertainty (regarding future cash-flows and the capabilities of the firm), flexibility (regarding the timing, and size of the investment) and irreversibility (as there are significant irreversible costs associated with the decision to diversify). Studying the boundaries of the firm will allows us to broaden our understanding of how firms

generate or destroy value, and so the study of corporate diversification provides relevant insights and contributions to the way we understand firms and financial theory in general. The paper will be structured as follows: the second section will review the main different theoretical lenses through which diversification has been analyzed and existing models, in the third section we develop our theoretical model and analyze its predictions, in the fourth section we develop an extension to this model, in the fifth section we test some of the model's predictions, and finally we conclude and comment on limitations and pathways for future research.

Chapter 2

Literature review

2.1 Diversification

We will review on this section, some of the most pertinent empirical evidence, and three of the main theoretical lenses used to analyze the complex phenomenon which is diversification, and which provide different insights into this puzzle, despite many aspects of different explanations being intertwined (for example Agency predictions and the misallocation of capital by internal capital of markets).

2.1.1 Conflicting Empirical Evidence

Evidence of diversification is contradictory. If on one hand, there are indications, that in general investors have positive reactions to diversification announcements (Graham et al., 2002), other papers such as Morck et al. (1990) find evidence of a negative reaction.The effect, of diversification on the value of firms is not straightforward and has been studied to be significantly influenced, by many factors.

Early studies on corporate diversification found significant evidence of a negative relation between firm diversification and performance (ex: Berger & Ofek (1995) for U.S. firms,Lins & Servaes (1999) for Japanese and UK firms). These results were soon contested, as they failed to account for the endogeneity of the diversification decision, the fact that firms who diversify and those who do not may have different fundamental characteristics, which are the true responsible for the apparent diversification discount. Campa & Kedia (2002) find the diversification effect is statistically insignificant and even more likely to be a premium rather than a discount firms, Hyland & Diltz (2002) find abnormal monthly returns in the 37 months surrounding the diversification are not statistically different from 0, and Graham et al. (2002) find only firms which become multi-segment through acquisition experience a value loss, but that this loss is associated with the acquired company already being previously discounted before the acquisition. Villalonga (2004), found that when controlling for endogeneity, the diversification discount is no longer statistically significant with results being robust to several changes in measures and samples. However, more recent studies who also account for endogeneity, also present mixed results. Lamont & Polk (2002) find exogenous increases in diversification destroy value, when the company is already diversified, while Hoechle et al. (2012) find a discount which

remains significant and negative even after considering endogeneity and control variables. Miller (2006) on the other hand, finds evidence diversified firms create more value than specialized firms, and that this value increases with technological diversity, which is a measure of the potential for economies of scope in knowledge assets, after controlling for R&D and Capital intensity.

Some authors, explore the effect of diversification on productivity. John & Ofek (1995) find that refocusing, through asset sales, increases operational performance on the years following diversification, for the parent company. Desai & Jain (1999) also find evidence that focusing spin-offs have higher abnormal returns, then non-focusing spin-offs, and are associated with increased operational performance. Some interpret these results as suggesting diversification may lead to inefficiencies, which are corrected once the firm refocuses.Krishnaswami & Subramaniam (1999) also find positive returns, which are positively related to the degree of information asymmetry before the spin-off. Çolak & Whited (2006) confirm that improvements in efficiency usually follow divestments, however they show it is unlikely that this increase is caused by refocusing. After controlling for the factors which increase the likelihood of a company diversifying such as size, and measurement error in qs they find no evidence of improvement in performance. They point out however, this might not be the same for the allocation of other types of resources, such as managerial expertise. Schoar (2002) finds diversified firms are more productive than stand-alone firms, and that they increase the efficiency of the firms they acquire. However, diversification destroys value dynamically as the productivity of the incumbent plants of the firm diminishes, leading to a negative net effect on total productivity. Maksimovic & Phillips (2008), also look at acquisitions as well as capital expenditures, and find evidence conglomerates increased plant productivity both in post-acquisition and for plant openings in growth industries.

2.1.2 Agency Theory

Agency Theory, pioneered by Jensen & Meckling (1976), gained preponderance in the 1980s and theorized that diversification may be pursued by managers, in their own interest, rather than in the interest of the shareholders they represent. Empirical evidence supportive of a diversification discount, was thus perceived as evidence of inefficient diversification, pursued by managers to increase their power, perquisites or compensation, as managers over-invested into less profitable opportunities (Jensen (1986) and Stulz (1990)) with the objective of reducing their own employment risk (their position, or reputation) (Amihud and Lev, 1981), or to increase their entrenchment, by making manager-specific investments which increase costs for shareholders to replace them Shleifer & Vishny (1989). These hypothesis were supported by some empirical results, for example, Campa & Kedia (2002) observe differences in ownership levels between diversifying and non-diversifying firms, and that diversifying firm have more cash and poorer performance than peers. Berger & Ofek (1995) report a 13 to 15% discount for US firms, identifying overinvestment and subsidization of poorly performing segments as the main drivers of this discount. Lins & Servaes (1999) find a diversification discount looking at 7 emerging countries, concentrated in groups where possible agency problems are higher, and that own-

ership structure influences the decision to diversify in these countries. Aggarwal & Samwick (2003) find evidence in support of the view managers diversify to increase private benefits, and that with increased benefits managers become less sensitive to performance incentives. Hoechle et al. (2012) find evidence that a significant part of the diversification discount (16 to 37% depending on the model) is explained by poor corporate governance

2.1.3 Internal Capital Markets

Diversification allows companies to create internal capital markets, as companies may decide in which segment they wish to allocate their capital. Under this perspective, diversification can both create or destroy value dependent on the level of efficiency of the internal capital market generated. Diversification may create value when it increases monitoring incentives and asset redeployability (Gertner et al., 1994) or improves the reliability of capital supply, particularly helpful during credit constraints (Liebeskind & Srogl, 2000). Finally, through improvements in lender information as top managers face less asymmetry of information than external lenders, as long as gains are not offset by increased information asymmetry for external investors (Krishnaswami et al., 1999). However, it may also destroy value since as diversification increases, so does the potential for the miss-allocation of capital. Diversification will destroy value if managers act as rent-seekers leading to inefficiencies in the allocation of capital in internal capital markets, with the subsidization of worse performing segments (Scharfstein & Stein, 2000), as investment decisions become political battles (Rajan et al., 2000) (in line with the agency view), Finally, diversification may reduce entrepreneurial incentives, as capital generated in a segment may be used for another segment (Gertner et al., 1994). Wulf (2009) defend that the quality of investment decisions of internal markets depends on the quality of the information, public and private, available.

There is significant evidence that the value of diversification is affected by capital markets, and that the efficiency of internal capital markets varies considerably depending on market and governance conditions. Diversified firms seem to have an advantage over periods of financial constraints, but are more inefficient in times of financial slack. Dimitrov & Tice (2006) find bank-dependent diversified firms (firms which rely heavily on banks in order to have capital) have better performance, higher growth of sales and inventories that their focused counterparts. Aggarwal & Zhao (2009) find diversification to be value enhancing when external capital markets are relatively inefficient(as in the case of emergent high-tech industries) and value destroying in mature industries. Yan et al. (2010) and notice investment levels decrease under external capital constraints for stand-alone firms during financial crisis, but not for diversified firms, and that internal conglomerate capital allocation efficiency increases as well. In contrast, Ozbas & Scharfstein (2009) observe unrelated segment firms, invest less in high-Q industries, than their stand-alone counterparts. Hovakimian & Li (2011) find that during non-recession periods, internal capital markets are inefficient as diversified companies allocate too much capital to low growth opportunities, but that they enhance their efficiency, during recessions and reallocate their capital to higher growth segments, especially those who were already

under financial constraints before the recession. Glaser et al. (2013) identify cash windfalls in multinational conglomerates, as a source of misallocation of capital, as more powerful and well-connected managers obtain higher amounts of investment rather than capital being efficiently allocated. Finally, Kuppuswamy & Villalonga (2015) show that the value of diversification increased during the 2007-2009 financial crisis, due to both financing and investment advantages, as conglomerates increased the efficiency of their internal allocation of capital significantly. Yet, they also found, a subsequent decrease in the efficiency of the allocation of capital back to pre-crisis levels.

In sum, evidence seems to suggest that for capital sufficient segments, diversification carries higher costs than benefits, and that benefits should be higher the higher the ratio of capital constrained segments, and the lesser the degree of development of the external capital markets.

2.1.4 Diversification, RBV and the Dynamic Capability Approach

The Resource Based View (RBV), pioneered by Penrose (1959) and Wernerfelt (1984), conceptualizes firms as bundles of resources, idiosyncratic and difficult-to-imitate firm capabilities and assets, which are fundamental to create and maintain a competitive advantage, and limit a firm's capacity to expand. They argue firm decisions depend not only on the opportunities it faces, but also the (not only financial) resources it possesses to successfully undertake investments. Under this view, firms are heterogenous, and resource endowments are difficult to change in the short-term, because some resources are not readily tradeable, capabilities are difficult to develop quickly, and as Lippman & Rumelt (1982) first noted, causal ambiguity limits the ability to imitate successful firms. Furthermore, there is path dependence in a firms development as expansion paths depend on past decisions resource, the firms business processes, and market positions. Teece et al. (1997), first proposed the notion of dynamic capabilities, updating the resource based view, referring to the ability to integrate, build, and reconfigure internal and external competences to achieve new forms of competitive advantage and address rapidly changing environments (Helfat & Peteraf (2009), address how the concept of dynamic capabilities was extended, to incorporate the notion, that firms can use those capabilities, but are not required to do so (they have an option), and that there must be some extent of intention). If resources are central to firm success, the ability to learn, manage, destroy, recombine, acquire, and accumulate skills, organizational and intangible assets is thus key to thrive in innovative and competitive environments, as firms must be able to reinvent itself, embracing internal and external change, and to explore and create new markets, while protecting against replication by rivals. Eisenhardt & Martin (2000) view dynamic capabilities as a set of specific and identifiable processes, which are idiosyncratic and path-dependent, but exhibit commonalities and allow firms to reconfigure their resources, to sustain long-term comparative advantages. They are more stable in moderately dynamic markets, where the emphasis is on small frequent variations, with dynamic capabilities being embedded in the form of routines in existing knowledge, and less predictable in very dynamic markets, where the em-

phasis is on selection of what to keep from experience, and integrating new, specific knowledge to adapt to changing environments, and find that dynamic capabilities are influenced by well-known learning mechanisms, such as repeated practice or experiencing crisis. Teece (2007)divides dynamic capabilities into three categories: the capacity to sense and shape opportunities and threats, the capacity to seize opportunities and the capacity to maintain competitiveness.

Sensing opportunities involves identifying emerging opportunities which are sometimes hard to discern. Entrepreneurs may have different access, different capacity to interpret, shape or even create new knowledge and opportunities. Thus, to identify new opportunities firms must constantly scan, and search for new technologies and markets as the information filters and knowledge that previously made a company successful can later constraint its growth. Management must find methods to gain insight on the opportunities and lift the fog of uncertainty, given that attention is a scarce resource (Simon, 1955) which must be carefully allocated.

Seizing refers to addressing the opportunity, and involves maintaining and improving technological competences and complementary assets, i.e. knowing when, where, how and how much to invest. The firms organizational capabilities and business models are at least as crucial to be able to effectively take advantage of the opportunities, as the physical technology to be used or market to be targeted. The timing for commitment depends heavily on the nature of the opportunity, the firms position, and existing resources. Firms may even avoid investing in radical innovations which might render useless their previous competences, in favor of incremental competency-enhancement investments, which build upon their already existing competences. The companys current endowments can exacerbate decision making biases against innovation, and lead to excessive risk aversion, and that is why it is important for firms to be aware of the relationship between their established assets and decision-making bias. These issues of co-specialization, opportunity costs and irreversibility make seizing opportunities particularly challenging, and even more in rapid changing environments, and our model will focus on this particular aspect. It stems from this view the idea that related diversification, i.e. diversification into segments which rely on the same resources and capabilities firms have, should be more beneficial, has firms take advantage of their unique resource profile and exploit complementaries.

2.1.5 Relatedness

Relatedness is a key aspect in the study of diversification from a resource-based perspective, and more so in our model, and so we will present a more detailed review of the subject. Relatedness, the degree of similarity between two segments is a multidimensional concept, which has proven hard to measure from early studies based on rather subjective criteria (Rumelt, 1974), through specific measures for different activities (Coff, 1999) or through managerial surveys [1] Stimpert & Duhaime (1997), which proved hard to generalize. The standard approach in the literature, is measuring relatedness through SIC (Standard Industry Classification)-Codes or similar measures (NACE, NAICS) , considering related businesses based on the

[1] refer to Pehrsson (2006) for a more complete review

hierarchy defined by this measures (as those who share the first 2 or 3 digits). Nevertheless its usefulness , this approach presents some limitations. Firstly, the SIC system mostly reflects a logic of vertical structure and shared primary raw materials (scattering competitors who produce substitute goods from different materials), and for some categories (electrical equipment or apparel) end use plays a significant role. It contains little information concerning strategical relationships, or the way firms combine resources to create value (Bryce & Winter, 2009). Secondly the fact, that they offer only a discrete view of relatedness, usually just a dichotomous related-unrelated view of diversification, providing limited information about the degree of diversification, and even possibly misleading information (consider that for example SIC 2951, Paving Mixtures and Blocks, and SIC 3273, Concrete, Ready-Mixed, are considered unrelated). It also fails to distinguish different relatedness levels between different industries in the same group, which can be quite relevant.

Other aproaches were based on determining relatedness by observing the empirical decisions made by firms (Folta & O'Brien, 2008). At a macro level, the work of Hidalgo et al. (2007) as provided a macro view into relatedness, based on the co-occurrence of products in countries export baskets,to build what they name as the product space, defining each industries space in a network. They also calculate a measure of the complexity, as they define it the amount of explicit and tacit (know-how) knowledge required, of different industries. They find the complexity of the basket of products a country produces is not only a better predictor of current wealth, but a better predictor of growth than traditional variables Hausmann et al. (2014), and that higher complexity is associated with lower inequality Hartmann et al. (2017), which further justifies the interest of policy-makers in diversification, in particular that into more complex goods. Subsequent work shows path dependence in the way countries develop new capabilities, diversify into products which are close to the ones they (Neffke et al., 2011)), or their neighbours (Bahar et al., 2014) already export. Bryce & Winter (2009) developed a resource-based general relatedness index based on information embedded in the multi-product organization decisions of diversified firms, providing a percentile relatedness rank for all four-digit SIC industry pairs which try to reflect the unobservable ways that firms share resources among industry activities. The index is created on the assumption the activity patterns of existing firms are good indicators of how resources and knowledge relate across diverse activities, given that existing firms are repositories for resources, skills, and knowledge. Industries are considered more related if a higher percentage of firms simultaneously perform in both segments (similar to the product space) than would be randomly expected. The general index is tested for predictive validity and found to perform well.

Neffke et al. (2017) use a network approach based on Germanys social security records labor flow data which spuns over 80% of the population, to derive a measure of human-capital relatedness. Their argument spurs from assuming that human capital is to some extent industry specic, and so labor-ows will be constrained and will predominantly take place between industries which are more closely related, i.e. with similar human-capital requirements. The resulting skill-relatedness network is stable over time, independent of whether workers switch jobs locally or over larger distances and similar for different types of workers (managers, sales, accountants,

IT, etc) suggesting a non-negligible industry-specic component in human capital.

Finally, another recent development in measuring relatedness is through text based analysys of corporate reports. Hoberg & Phillips (2016) create new industrial classifications, departing from 10-K product words describe the features and bundles of products each firm offers. They create two classifications: one similar to SIC (which they distinguish as fixed) which holds its mains properties(namely transitivity), and a general industry classification which can be represented as an unrestricted network of firms. In this second network, each firm can have its own distinct (time-varying) set of competitors, with significant empirical predictability.

Empirically, Kaplan & Weisbach (1992), analyzed acquisitions in the US from 1971 to 1982, and found firms are more likely to divest from unrelated segments. However, they do not find evidence that unrelated acquisitions are less successful than related acquisitions, with a third to half of the divestitures being considered as unsuccessful, i.e. have incurred on a loss with the sale. Some studies report evidence of better performance (or not as bad) in case of related diversification, such as Berger & Ofek (1995) (measuring relatedness using two digit sic codes) and Helfat & Lieberman (2002), who additionally find that firms and entrepreneurs which move into segments related with their current/previous segment have higher survival rates and are able to enter the market much quicker. Palich et al. (2000) conduct a meta-analysis of over 50 studies, and conclude in favor of an inverted-U relationship between performance and the degree of relatedness (moving from specialized, to related diversification to unrelated diversification). Maksimovic & Phillips (2008) find more skilled firms in particular industries are more likely to maintain and increase the productivity of the assets they acquire and keep in related industries. Other studies, find no difference in the effect of related and non-related diversification, such as Park (2002), who finds that after accounting for ex-ante differences (more ex-ante profitable companies have higher propensity to persecute related diversification strategies rather than unrelated diversification) and initial industry differences, there is no significant effect on performance. Akbulut & Matsusaka (2010), studied over 50 years of acquisitions, and found significantly positive combined returns for diversifying mergers, not statistically different from those of related mergers (where firms share at least one of the 6 major segments Sic codes). Neffke & Henning (2013)examine firm level data, and find firms are over 100 times more likely to diversify into closer industries.

2.1.6 External Factors

Besides the pointed explanations which are more primarily related to the internal aspects of the firm, some research also focuses on the influence of external aspects such as institutions and the competitive environment the firm is facing. Wright et al. (2005) present the concept of institutional relatedness, the informal linkages of an institution to dominant power which confer resources and legitimacy. They propose that the higher the institutional relatedness, the larger the scope of the firm, and the higher the development of capital markets and of formal market-supporting institutions, the lower the scope of the firm. Furthermore, the benefits from institutional relatedness in developing countries is likely to be higher in the short term,

as economies transition as better-connected firms may serve as intermediaries, and lower in the long-term as the countries develop. Bowen & Wiersema (2005) study the influence foreign competition may have on US firm diversification decision, and found statistical support for their hypothesis that increased competition would reduce unrelated diversification, due to managerial constraints, and increase related diversification, as firms try to better leverage the firms existing resources, and that this result was stronger, i.e. higher focusing and increased interrelatedness of resources, the more attractive the firms core business and the lower the previous performance of the firm. Chakrabarti et al. (2007) find evidence of a diversification premium only in less institutionally developed countries, studying firms from 6 different Asian countries with different levels of development, and a diversification discount in more developed countries, with the benefits of diversification being contingent on economic stability.Santalo & Becerra (2008) discovered that the effect of diversification is not homogenous among industries, measured by four-digit SIC code when analyzing a sample of US firms. They found a diversification premium, where there is a small number of specialized competitors, or when they have a lower market share, and a diversification discount otherwise, robust to industry size and concentration and controlling for the self-selection bias.

Hoberg & Phillips (2010)nalyse 10-K product descriptions, and find mergers and acquisitions are more likely between firms that use similar product market language. Furthermore, performance improves for transactions with similar product market language, with gains being larger for targets with unique products which are less similar to the acquirer rivals. Kuppuswamy et al. (2014) investigate diversified public firms from 38 different countries, over a 15-year period, and find diversification is more valuable in countries with less developed labor and capital markets. What this mixed evidence reveals, is that diversification will have different effects depending on the characteristics of the firms, and the characteristics of the environment firms operate in, and this must be reflected in the model.

2.2 Related Models

In this section, we will review in detail the existing dynamic models of diversification as a value-maximizing strategy.

Matsusaka (2001) develops a dynamic model based on the notion of organizational capabilities. Firms own difficult to replicate (transfer) organizational capabilities, meaning it might be beneficial for owners, that companies find other lines of business, where these capabilities may be useful, instead of shutting down. The paper explores the notion that diversification is a matching/search process for a company to find a business with a good fit to its own capabilities, consistent with empirical evidence from conglomerates acquisitions and divestitures in the 1960'S. This stems from the uncertainty regarding the fit which can only be solved through experimentation due to bounded rationality. This provides an explanation for some mixed reactions to diversification announcements: diversification can be perceived as good news, due to signalling there are organizational capabilities which are profitable enough to avoid liquidation, or bad news signaling the company is in need of exploring new possibilities. Furthermore, the model predicts diversifiers will act

as risk lovers as the value of diversifcation increases with uncertainty as firms may abandon the business in case of poor performance, while completely gaining from the upside potential. Competition causes the erosion of a firms organizational fit over time, and breeds diversification, since it is more likely that a companies advantages will be eroded, the firm will search longer for better fits (smaller opportunity cost in exploring new opportunities).

Bernardo & Chowdhry (2002), use a real options framework, to also explore the value of the information that a firm may obtain regarding its resources (as they define it, the capabilities, skills and assets of a company) in a context of uncertainty when investing. They divide the resources a company may possess in two groups, and define two projects the firm may undertake: general and specific, with general resources influencing the cash-flows of all projects, and specific only influencing the cash-flows of the specific project, with companies having the irreversible option to expand at a given segment. Companies infer the total sum of resources they possess while focused, but not which kind, and thus will experiment with the general project to generate better signals (cash-flows, revenues, market share),before decide to focus and expand the specialized project, or expand the general project. Their main conclusion is a new explanation for the diversification discount: There is higher uncertainty regarding a new firms resources, since it had less time to resolve this uncertainty, which is associated with a higher value of the firm. As diversified firms are usually more well-established older firm, there is less uncertainty regarding their resources, and so young firms with the same expected resources will have higher option value. Borghesi et al. (2007) and Hund et al. (2010) find empirical evidence consistent with the view proposed in this model, that older firms with lower uncertainty regarding their returns are less valuable than younger firms, where there is more returns uncertainty.)

Gomes & Livdan (2004) depart from a neoclassical point of view, and show that an apparent diversification discount is consistent with rational and efficient decisions, in a context of decreasing returns to scale, firm heterogeneity (firm specific productivity leels) and costly sector mobility. Their model shows that even before taking into account any possible behavorial or agency problems, diversified firms present lower value, while remaining nevertheless efficient, by allowing firms to explore new productive opportunities and synergies, and have lower cash-flow risk. Firms will diversify once they become relatively unproductive, which endogenously, given the interaction between firm size and productivity, generates the apparent diversification discount. This is consistent with empirical evidence, such as Lang & Stulz (1994), and other studies, who found that diversified firms had lower Tobin's q-ratio than focused firms.

Levinthal & Wu (2010), depart from a RBV, and distinguish scale-free from non-scale free capabilities, firm specific capabilities who are subject to an opportunity cost and must be allocated to only one segment. These are subject to imperfect input markets, and might translate anything from the attention of the top management team to scarce product capacity. Firms must decide how to allocate a given capability stock between two different sectors. Capability allocation is not related to scale, and firms are able to scale up at a constant marginal cost. They analyze the effect on productivity and value of diversification under Bertrand and Cournot type

competition . In the Bertrand model, the firm which is able to have a smaller cost is able to serve the whole market. If that firm chooses to diversify, its profitability and Tobin's q will be smaller than the weighted average of the profitabilities for focused firms in the two segments, due to a discount caused by the spreading of non-scale free capabilities and dependent on the degree of fungibility of scale free capabilities (how productive they are in the new segment). This is, nevertheless, consistent with a value maximizing strategy, as firms maximize total profits rather than marginal profits. Firms diversification decisions will differ depending on the size of the markets, and on the capability assymetry between firms. More capable firms will diversify first, and average returns will decrease.

Sakhartov & Folta (2014), take a very distinct approach and study how resource relatedness affect redeployability, formally defined as an american option to withdraw an asset and apply it in another market. The traditional approach to synergies, what they call intra-temporal economies of scope, relates to the contemporaneous sharing of assets, which allows savings due to reduced excess capacity, but usually dismisses the possible inter-temporal economies of scope (Helfat & Eisenhardt, 2004), i.e. the redeployment of resources from one business to another over time, which has particularly significant implications for the optimal timing of decisions when making combined enter and exit decisions in dynamic environments, with greater uncertainty, as it decreases irreversibility, allowing firms more flexibility over the use of their resources. Resource sharing generates an increase in returns, either be reducing costs or increasing revenues, positively related to relatedness. Firms choose the asset allocation among the two different markets. Sakhartov & Folta (2015) further study how model how return correlation between two industries, current return advantage and volatility of the existing markets influence the value of synergies and relatedness, and how they interact to affect the value of redeployability. Sunk costs, uncertainty and market exit: In a real options perspective O'Brien & Folta (2009) suggest that the value of keeping an option alive is smaller for related firms due to lower sunk costs, but empirically find that firms are more likely to exit industries that are unrelated to their businesses. Relatedness influences not only a firms ability to leverage its resources but also how it might do so, as firms may more easily enter and exit related industries. Attempting to differentiate ones products in the industry via innovation may result in becoming locked into the industry because of high sunk costs. Finally, Sakhartov (2017) demonstrate diversified firms are more likely to combine moderately related businesses than the most related businesses, given strong relatedness reduces redeployment costs and makes firms redeploy all resources to better performing businesses.

Chapter 3

Basic Model

3.1 Model Setup

As reviewed in previous sections, diversification is a complex decision, and agency theory and internal capital markets have provided important insights, regarding factors which can significantly affect the value of diversification. However although they provide insight over *why* firms diversify, they have limited potential in explaining to *where* should firms diversify. In this dissertation we propose to develop a Real Options model which will focus on a RBV/DCA, although it is possible adjustments are made to accommodate other views. This is justified given the importance resources, and strategic reasoning have on manager decisions (McKinsey, 2015) and the potential this view recognizes for firms to create value through diversification. We propose to contribute to the discussion on diversification, exploring the decision from an unusual angle, hoping to provide testable insights regarding the external and internal conditions under which diversification may be a value generating decision, in order to contribute for a more holistic view of the phenomenon.

In our basic setting we consider a Firm, which is active in a given segment a, having a capital stock of K_1, who faces two important decisions regarding a possible future investment: *when* and *where* to invest a K_2 amount. The firm first decides where to invest in order to maximize its value, and finally determines the optimal moment to invest.

Our model (and the resource based view) implicitly assume managers are bounded rationally, as initially proposed in Simon (1955) . They have limited attention and specific competences (cognitive resources) which are hard to modify in the short term, and so they do not possess all the information, nor the capacity to perfectly interpret all available information. Even if managers can hire workers with a better understanding than them, the manager must first be aware of possible opportunities which will motivate this hiring, as McKinsey (2015) show that companies are likeliest to identify their executive teams and boards as the ones responsible for evaluating opportunities in new categories. This implies that new investments will change the portfolio of options, as they might be able to find new hidden opportunities, or lose focus through diversification. Hence when deciding where to invest, the firm considers the (cognitive) distance (or the inverse, relatedness) to the new segment, d in our model, and the profile of the trade-off related to its capabilities.

This distance where the firm may invest is normalized between 0, the current core segment a and 1, a completely unrelated segment. In our model, we conceive industries as occupying a position in an industry space. This conception of relatedness has some important implications. First of all, as shown in Hidalgo et al. (2007), the decision to diversify is different across different industries, as it is thus possible for some industries to be fairly well connected to many other, while others can be poorly connected, leading to different decisions, diversification patterns, and performance across industries. In our conception, a firm is more diversified if its segments are more distant. For simplification in our model, the firm will only be active in one segment prior to this decision, and considers only diversifying into one new segment.

The closer the firm invests, the higher the potential for savings from shared resources and capabilities, the more the company can benefit from its core capabilities (Markides & Williamson, 1994) as it finds new ways to explore them, the larger the benefit from switching options (from the "redeployability"), since it can choose in which segment it wishes to use the common capabilities and resources (Sakhartov & Folta, 2014), and thus investing in closer projects helps alleviate the problems of irreversible decisions, as these capabilities and resources may be more easily transfered to the initial segment , as well as benefit from inter-temporal economies of scope, i.e. sharing the resources at a given time (Helfat & Eisenhardt, 2004). On the other hand, the closer the investment, the higher the option duplicates, as well as the number of mutually exclusive options, which cannot be simultaneously exercised (de Andrés et al., 2014). Furthermore further expansion near the core segment, might imply capabilities being over-used, reducing organizational slack (Shayne Gary, 2005) which might hurt the firms capacity to pursue growth options, reduce efficiency, or lead to deseconomies of scale, and increase coordination costs (Zhou, 2011) which can counterbalance the possible gains. We desnote the net gains or loses of relatedness as θ_c in our model. Throughout this paper, we refer to synergies[1](in a strict sense) as a synonym of θ_c.

The further away the firm decides to invest, from its initial segment, the larger the potential for new growth options it may gain (due to, for example being more capable to identify hidden options), the higher the likelihood it might combine its capabilities, which are required to develop and pursue these options, in new ways and add further value to the options it already possessed, and the new information gained from being present in the new segment, may help improve the firm's valuation of existing options, reducing poor decisions and anticipating new value-generating exercises of options, as well as larger potential for further options, resulting from the conjugation of capabilities, from both segments. However given the firm's limited absorptive capacity ((Cohen & Levinthal, 2000), if it moves too far away, up to a point where the companies capabilities have limited to no use, it may lack the necessary basis to understand and effectively explore the new market, and thus hinder its capacity to reap the previously mentioned benefits, (citAndrés). Finally, given managers have limited attention, time and ability to process information the

[1]Although synergies usually refer to gains, we designate by synergies (etymologically: work + together) the (positive or negative) result of combing two segments' currently used resources and capabilities of the firm.

company may risk losing focus, and thus lose value on its already existing segment. The net value of the gains and losses from distance (moving further away), is denoted in our model as θ_{op}, and we consider θ_{op} is always > 0. Through out the paper we will use opportunities as a synonym of θ_{op}.

In sum, there will be a trade-off between the advantages of diversification: information gained regarding resources and capabilities, cash-flows gained and new options which might be revealed, and the costs of possibly losing focus: losing track of possible profitable opportunities due to shifting attention, and splitting resources and competences across industries.

As in Bernardo & Chowdhry (2002) the value of the firm is a function of its capabilities(resources), and likewise we will not pinpoint specific resources or capabilities which lead to better performance, as there are a number of problems with trying to pinpoint the specific resources which are responsible for a sustained competitive advantage [2] We assume X captures the relative fit of the total capabilities of an active firm used in the current business, which follows a Geometric Brownian Motion:

$$dX(t) = \alpha X(t)dt + \sigma X(t)dz(t) \tag{3.1.1}$$

where α is the risk-neutral drift rate, and is equal to $r - \delta$, dz is the increment of a Wiener process, and σ is the standard deviation. The firm is risk neutral and discounts against rate r, the risk-neutral risk-free rate and δ represents the opportunity cost for delaying investment, and is larger than 0.

The interpretation of these elements, given they relate to capabilities rather than cash-flows, has some nuances: namely α represents the rate at which companies learn new capabilities [3] , in relation to their competition, an α of zero implies the firm expects its capabilities to evolve similarly to their average competitor, while for example a negative α would mean the company expects its capabilities to develop at a smaller pace than competitors implying the firm will lose some ground. σ represents the volatility around the fitness of the capability in the market. The more hyper-competitive (dynamic) a market is, and the more subject to major innovations and disruptive competitive changes, the higher this volatility will be. A higher σ thus implies, larger uncertainty around the usefulness of the firm's capabilities.

For the sake of simplicity we also have to make some assumptions. As the firm can have the same distance to two very different industries, with different profile of gains and losses, given our network conception of relatedness, we assume the company has already identified the most advantageous direction to follow although not the specific industry(product) it will produce, and identified the profile of synergies across the different distances. Furthermore, although capabilities vary over the long-term, the firm cannot actively increase its capabilities in the short term, nor increase the

[2] see Sanchez (2009)

[3] Or find a way to better fit their current capabilities in their segment, we use improve capabilities, fitness of capabilities and usefulness of capabilities as synonyms. An improvement of these implies the increase of X, whether it came from learning a new capability or simply finding a better use to an already existing one. We also use plural and singular form equally, as X, can be understood as the value of a given capability, which is the only relevant one, or as a measure of the value of a portfolio of capabilities

capability growth in the long term. However, the firm can expand while maintaining its current capability level. This is consistent which some findings on the literature, such as Kor & Leblebici (2005) which find that that financial performance suffers when firms diversify at a faster rate than what its current human capital can handle as there is some stickiness on a firms human capital profile, and that productivity can even be reduced when firms have a high reliance on external sources of human capital (acquisitions). For such reasons, we consider the best case scenario, of constant capabilities (returns may still vary, due to θ_c and θ_{op}, i.e., the company may benefit from, for example, saving from the layoff of duplicate employees, or benefit from using its current capabilities in new segments, respectively). Finally there are no restraints to when the firm must make its decisions, i.e. the option has no expiration.

3.2 Optimal distance and timing

Considering our basic setting, in which a firm is deciding where and when to invest a given amount K_2, the payoff of the investment decision for the firm will be:

$$V(X,d) = X(1-d)K_2 + \theta_{op}(1-d)dK_2 + \theta_c(1-d)(K_1+K_2)\frac{K_2}{K_1} - K_2 \quad (3.2.1)$$

The payoff can be divided in the standalone value of the firm, plus the value of opportunities and synergies from the investment decision. The $(1-d)$ component in all terms translates the notion that the further away from the core segment, the smaller benefits the firm will reap from its existing capabilities and sharing of resources. This may be due to the firm being less efficient as it moves further away from its core (Eckel & Neary, 2010), or due to the fact this capabilities are not as effective in enhancing the quality of the output of the firm in the new segment (Manova & Zhang (2012); Eckel et al. (2015)).

The first part of the payoff $X(1-d)K_2$ translates the value the company will be able to derive in the new segment, from its existing capabilities, without considering the possible benefits from diversification itself., i.e. it is the value the firm would generate from the segment if it only operated that single segment, and it depends on the capabilities (in that segment, $X(1-d)$) and investment size. The next two components of the payoff, refer to the opportunities and synergies. The value the firm obtains from opportunities, depends positively on the size of the new investment and θ_{op}. Distance, however, has a non-linear effect. While on one hand, moving further away increases the potential for opportunities, on the other hand it implies fewer benefits (due to higher costs to adapt to the new segment, or smaller benefits from already existing capabilities), this is translated in the $d(1-d)$ component. Synergies on the other hand, relate to the combined value of both the new and the old investment (K_1+K_2), and are increasing with the investment size: if the new investment is too small, the potential for sharing across segments, and exploring relatedness is much smaller. Value from synergies is only derived if the company makes a significant enough investment to materialize this benefits. On the other hand, when θ_c is negative, for example if the resources or capabilities the company depends on, are not abundant, the larger the investment, the larger the negative

impact (from for example, reducing slack or increasing coordination costs). Finally, the company will have to pay the investment cost K_2.

We consider the firm first decides where to invest, and then when to invest. We can determine the distance which maximizes firm value, through a simple optimization exercise, by maximizing $V(X, d)$ in order to d.

$$\max_{d\in[0,1]}[V(X,d)] \tag{3.2.2}$$

Proposition 3.2.1 *The optimal distance in which to invest, for a given K_2 and any X, is given by:*

$$d^*(X) = \frac{1}{2} - \frac{XK_1 - \theta_c(K_1 + K_2)}{2K_1\theta_{op}} \tag{3.2.3}$$

This equation is the solution to the *where to invest* question, if we do not consider the effect of uncertainty and the investment size is given. From the expression we can see that , ceteris paribus, more capable firms would invest closer to the original segment, and thus be less diversified (with the effect being mediated by the opportunities of the new sector). As we will se in the example above, higher synergies will imply closer optimal distance, and opportunities lead to increased distance. Larger firms will invest further away, when synergies are positive than smaller firms (smaller K_1), under the same circumstances, and closer when they are negative. As for investment size (K_2), under positive synergies, the higher the K_2 the closer the optimal distance, and under negative values the further away should the firm invest.

Thus, the optimal diversification of a firm, when K_2 is given, due to financial constraints or managerial motives, depends on the size of the firm, and thus different sized firms (or the same firm at different stages in time) will opt to diversify into different segments, in the presence of the same synergies, opportunities, capabilities and absolute investment size. Furthermore, if we relate synergies, to the industry stage, assuming synergies will be mostly positive for most firms, on the early stages of the industry as there is still a lot of market, resources and capabilities to explore, and negative after a certain maturity is reached, so that increasing size will reduce performance(reduced margins, increased organizational costs), the model suggests very different optimal behaviors. In mature industries, smaller firms will diversify further away, distancing themselves from the current sector to explore opportunities more easily as they are less invested into the current sector and will suffer smaller costs from moving (as well as larger relative benefits), while the larger the investment the further away it should be made in order to explore the opportunities and minimize the effects of the costs of θ_c. In younger industries the opposite should happen as larger firms invest (smaller investments) further away, while larger investments(or by smaller firms) should be made nearby in order to capitalize on the industries core resources and synergies.

Following the definition of the optimal distance for any X, the firm must decide on the timing of investment, in terms of the level of capabilities from which it is optimal to diversify (indirectly, this also defines the value trigger).

As is standard in the literature [4], the value of the option to invest, $F(X,d)$, must satisfy the following ordinary differential equation:

$$\sigma^2 X^2 \frac{\partial^2 F(X,d)}{\partial X^2} + (r-\delta)X\frac{\partial F(X,d^*)}{\partial X} - rF(X,d^*) = 0 \tag{3.2.4}$$

The solution to the ODE takes the general form:

$$F(X,d^*) = {A_1}^{\beta_1} + {A_2}^{\beta_2} \tag{3.2.5}$$

where:

$$\beta_1 = \frac{1}{2} - \frac{\alpha}{\sigma^2} + \sqrt{(\alpha\sigma^2 - \frac{1}{2})^2 + \frac{2r}{\sigma^2}} \tag{3.2.6}$$

$$\beta_2 = \frac{1}{2} - \frac{\alpha}{\sigma^2} - \sqrt{(\frac{\alpha}{\sigma^2} - \frac{1}{2})^2 + \frac{2r}{\sigma^2}} \tag{3.2.7}$$

As the payoff is that of a call option, i.e. increasing in X the solution, as is standard in the literature, takes the form:

$$F(X,d^*) = {A_1}^{\beta_1} \tag{3.2.8}$$

Which from now on, we designate as A and β (which must be greater than 1). To determine the optimal timing X^*, we employ the value matching and smooth pasting conditions:

$$\lim_{X\to X^*} F(X^*,d^*) = V(X^*,d^*) \tag{3.2.9}$$

$$\lim_{X\to X^*} \frac{\partial F(X,d)}{\partial X} = \lim_{X\to X^*} \frac{\partial V(X,d)}{\partial X} \tag{3.2.10}$$

The value matching condition, equation 3.2.9, establishes that in the optimal moment of investment the value of the option to defer the investment is zero, where X^* is the optimal investment trigger, i.e. the value of the option to invest is equal to the present value of the risk-adjusted cash-flows the firm will receive. The final condition, equation 3.2.10 ensures that $F(X,d)$ is continuously differentiable along X, and that $F(X,d)$ and $V(X,d)$ meet tangentially when X is equal to X^*. Solving this system, we can show the option value of the diversification decision is given by:

$$F(X,d) = \begin{cases} A\left(\frac{X}{X^*}\right)^{\beta}, & \text{for } X < X^* \\ A & \text{for } X > X^* \end{cases} \tag{3.2.11}$$

Where A is the payoff at the optimal moment of investment and is given by:

$$A = \frac{K_2(K_2\theta_c(-B+K_2\theta_c) - K_1(B-2K_2\theta_c)(\theta_c+\theta_{op}) - {K_1}^2(4(-2+\beta)\theta_{op} + (\theta_c+\ \theta_{op})^2))}{2{K_1}^2(-2+\beta)^2\theta_{op}} \tag{3.2.12}$$

And B is equal to:

[4] view Dixit et al. (1994)

$$B = \sqrt{K_2^2{\theta_c}^2 + 2K_1K_2\theta_c(\theta_c + \theta_{op}) + {K_1}^2(4(-2+\beta)\beta\theta_{op} + (\theta_c + \ \theta_{op})^2)} \quad (3.2.13)$$

The optimal timing (capability level) to invest [5] is given by:

Proposition 3.2.2 *The optimal timing for investment, at the optimal distance, and a given K_2 is given by:*

$$X^* = \frac{-(-1+\beta)(K_2\theta_c + K_1(\theta_c + \theta_{op})) + B}{K_1(-2+\beta)} \quad (3.2.14)$$

The optimal timing for investment is negatively(positively) related to β (uncertainty), in line with the literature that uncertainty leads to postponing investment. Higher opportunities and synergies lead to earlier investments, as they both represent higher gains. The effect of firm and investment size is, once again, contingent on the sign of θ_c. With positive synergies, the firm will invest sooner for larger K_2 , or smaller K_1, and so smaller firms will actually diversify sooner than larger firms, ceteris paribus. The opposite happens for negative θ_c, and so under the previous assumptions, in more mature industries larger firms will diversify sooner than smaller firms (In these conditions, as larger firms will diversify sooner, than their equally capable counterparts, it might be so that this leads to an apparent diversification discount, if the sample is comprised of mostly larger firms in mature industries, as the less capable firms are more likely to diversify, as they reach the threshold sooner, it may be that the difference in capability is the true responsible for a discount.)

And the optimal distance, at the optimal timing will be:

Proposition 3.2.3 *The optimal distance at which to invest K_2 at the optimal timing is given by*

$$d^*(X^*) = \frac{(K_1+K_2)\theta_c + K_1(-3+2\beta)\theta_{op} - B}{(2K_1(-2+\beta)\theta_{op})} \quad (3.2.15)$$

The introduction of the choice of timing and uncertainty has a significant effect on the optimal distance. β (uncertainty) has a positive (negative) relationship with distance (whenever the timing $\in \mathbb{R}^+$). And so in the presence of higher uncertainty firms will opt to diversify near the core segment. Surprisingly synergies now act in the same direction has opportunities: with higher synergies increasing the optimal distance. Effects of firm and investment size also shift, although still contingent on synergies. With positive synergies, distance is decreasing in K_1 and increasing in K_2. In negative synergies the opposite, now occurs. So under flexibility to define timing and uncertainty, larger firms (or for smaller investments) in mature industries will diversify further away (or for larger investments), while in a young stage of the industry lifecycle it will be smaller firms which will move further away.

[5] There is another value for X, which satisfies the conditions, but it does not produce valid results, i.e. where $0 \leq d^* \leq 1$, $X \in$ and a positive $V(X^*, d^*)$

3.3 Numerical Example

In this subsection, we will explore a numerical example to shed light on the model's intuition.

Variable	Value
K_1	100
K_2	50
X	1
θ_c	-0.2
θ_{op}	2.5
α	0
σ	0.15
r	0.1

Table 3.1: Base case parameters

The base case parameters are described in Table 3.1.
First we will look at the trigger, and the decision of the investment timing.

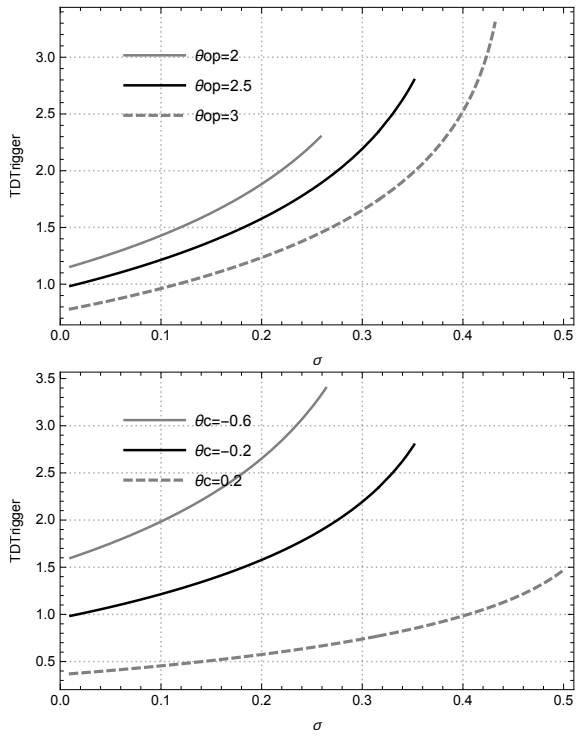
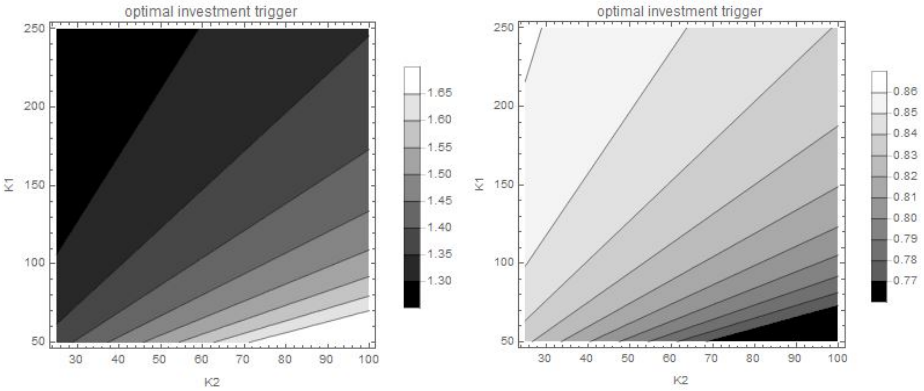


Figure 3.1: Investment trigger, uncertainty, synergies and opportunities

Effects are generally unambiguous, and as Figure 3.1 shows uncertainty increases the value of waiting and so leads to later investment, while higher synergies and opportunities increase the value of the investment and reduce the trigger. However, when it comes to investment and firm size the effect is contingent on the sign of θ_c as we see in Figure 3.2. With negative synergies, larger firms will invest sooner,

or those which make smaller investments, between two same size firms, while with positive synergies, the opposite happens.



(a) Negative θ_c (b) Positive θ_c

Figure 3.2: Trigger and Synergies

We can also analyze the conjunct effects of uncertainty and opportunities as in Figure 3.3, which shows both variables play a significant role on the decision of the timing. A very high level of uncertainty requires very large opportunities in order for a firm to even invest. y 9o0

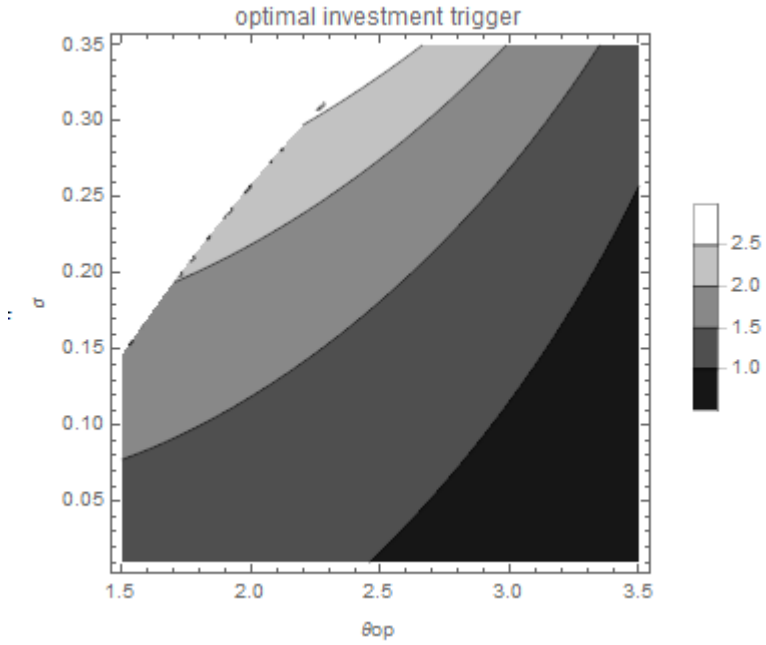


Figure 3.3: Trigger,θ_{op} Uncertainty

Figure 3.4 shows the relationship between the effects of opportunities and synergies. Synergies seem to have a stronger relative effect effect when they are negative, then when they are positive.

When it comes to distance we can do an analogous analysis. Uncertainty reduces the optimal distance, while on the other hand opportunities and synergies lead to higher diversification, as shown in figure 3.5.

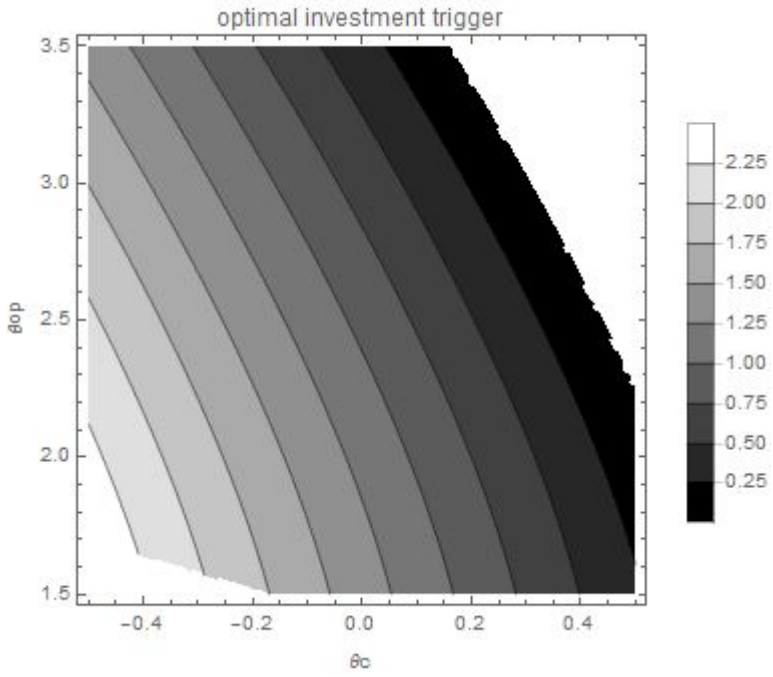
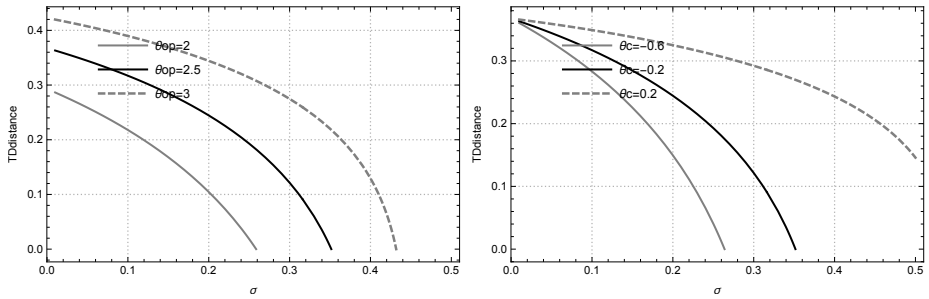


Figure 3.4: Trigger, θ_c θ_{op}



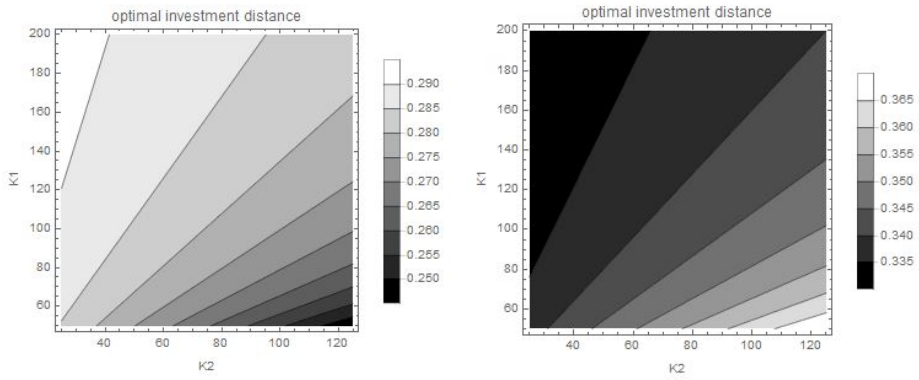
(a) θ_{op} (b) θ_c

Figure 3.5: Distance, uncertainty and inducements

By looking at investment and firm size in Figure 3.6, we can see that for a negative θ_c larger firms will invest further away, while for a positive value, smaller firms will have a higher optimal investment distance.

We can also take this numerical example to examine, and better understand, why do firms diversify in our model.

In order to do so, we compare the payoff of investing a given value in the original segment at a moment in time (in order to compare values at different triggers as suggested by (Dixit et al., 1994)), and investing it at the optimal distance and at half the optimal distance, in Figure 3.7. The vertical line marks the optimal timing for investment at the optimal distance, which happens when X hits 1.377. At that moment, diversification generates a value of 13.98, much higher than the 3.86 the firm would obtain investing in the same segment. If X decreases, diversification still creates a positive value, while remaining focused (i.e. investing at distance 0) would lead to negative returns. This shows that if firms have capital available for invest-



(a) Negative θ_c (b) Positive θ_c

Figure 3.6: Distance, Size and Synergies

ment, and yet do not possess significant enough capabilities to generate value in the current sector, it can nevertheless create value for shareholders through diversification. However, as X increases we can see that the premium of diversification over focusing decreases. This is due to the $X(1-d)K_2$ component of the payoff. As X increases, so does the cost of diversification, as the value loss from the imperfect application of capabilities increases in absolute terms. These costs become so high that, as we can see from around where X hits 2(if we consider the return of investment, instead of the total value, then this happens only X is around 3.5), diversification results in a loss of value. So very well performing firms have a higher absolute cost of diversification, and, in limit an infinitely capable firm would not diversify without uncertainty. However, as there is uncertainty, if capabilities significantly decrease for any reason, diversification serve as insurance and guarantees a better performance. This implies, companies would benefit from diversification whether to increase returns when capabilities are low, and as a guarantee of value when they are high, since if for some reason the competitive advantage the firm would dissipate, and X would decrease, the firm becomes better off as it still explores the opportunities in the new segment(as well as now having a smaller opportunity cost for diversification as less capabilities are "dissipated" in diversifying).

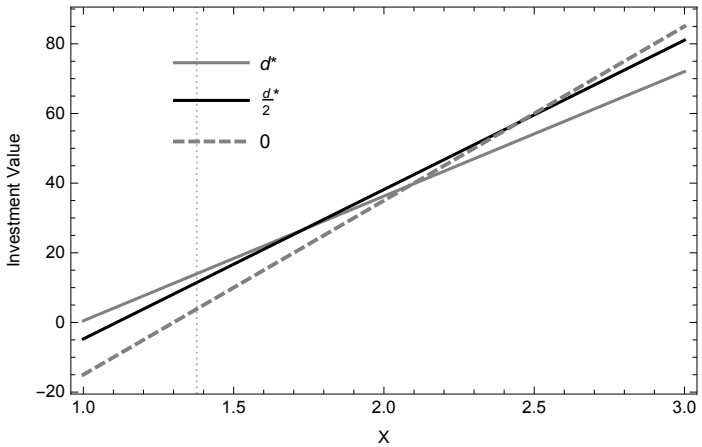


Figure 3.7: Dynamic Value of Diversification

Chapter 4

Extension to the basic model

4.1 Distance and timing with optimal capacity

In this chapter, we consider that beyond the previous decisions, the firm now must also decide the investment size K_2. In order to do this however, we must restrict the model to the analysis of cases where $\theta_c < 0$. When synergies are positive, although there is still a trade-off between synergies and opportunities when deciding on the distance, a bigger investment always generates a higher return, as synergies are increasing in K_2. So in such situations, companies will simply invest as much as possible, and can determine the distance and timing through the previous model (with their maximum investment capacity being K_2). Regardless, the most common and interesting cases are those were $\theta_c < 0$, where the firm faces some loss in efficiency (due to higher coordination costs, salaries, lost of slack and attention sharing between the two segments hurting the initial segment performance) as a trade-off to expand and be able to explore the new opportunities. The payoff will remain the one presented in equation 3.2.1

First, we must determine the optimal distance and size of the investment, for any given capability level. We can find the stationary points by solving the system:

$$\begin{cases} \frac{\partial V(X,d,K_2)}{\partial K_2} = 0 \\ \frac{\partial V(X,d,K_2)}{\partial d} = 0 \end{cases} \tag{4.1.1}$$

$$\begin{cases} \frac{\partial^2 V(X,d,K_2)}{\partial^2 K_2} < 0 \\ \frac{\partial^2 V(X,d,K_2)}{\partial^2 d} < 0 \end{cases} \tag{4.1.2}$$

These points will be a maximum/minimum in the regions where:

$$(\frac{\partial^2 V(X,d,K_2)}{\partial^2 K_2})(\frac{\partial^2 V(X,d,K_2)}{\partial^2 d}) - (\frac{\partial^2 V(X,d,K_2)}{\partial d, \partial K_2})^2 > 0 \tag{4.1.3}$$

The limits of this region translate the notion that, K_1 must be large enough for the firm to diversify, the opportunities must compensate the losses of θ_c, and if X is too

high the firm should already have invested. This region is defined by :

$$\begin{cases} -\theta_{op} \leq \theta_c < 0 \\ 0 < X \leq -\theta_c + \theta_{op} \\ K_1 > -\frac{3K_2\theta_c}{2X+2\theta_c+2\theta_{op}} \end{cases} \tag{4.1.4}$$

and

$$\begin{cases} -\theta_{op} \leq \theta_c < 0 \\ -\theta_c + \theta_{op} < X < -\theta_c + 5\theta_{op} \\ -\frac{3K_2\theta_c}{2X+2\theta_c+2\theta_{op}} < K_1 \leq -\frac{K_2\theta_c}{X+\theta_c-\theta_c} \end{cases} \tag{4.1.5}$$

These points will be maximums, since in our interval $0 \leq d \leq 1$, $K_2 > 0$, $K_1 > 0$ $\theta_{op} > 0$ and $\theta_c < 0$, and so:

$$\begin{cases} \frac{\partial^2 V(X,d,K_2)}{\partial^2 K_2} = \frac{2(1-d)\theta_c}{K_1} < 0 \\ \frac{\partial^2 V(X,d,K_2)}{\partial^2 d} = -2K_2\theta_{op} < 0 \end{cases} \tag{4.1.6}$$

The optimal K_2 and d , for any given X will be given by:

$$K_2{}^*(d^*, X) = \frac{K_1(-2(X+\theta_c+\theta_{op}) + \sqrt{12\theta_{op} + (X+\theta_c+\theta_{op})^2})}{3\theta_c} \tag{4.1.7}$$

$$d^*(K2^*, X) = -\frac{X + \theta_c - 5\theta_{op} + \sqrt{12\theta_{op} + (X+\theta_c+\theta_{op})^2}}{6\theta_{op}} \tag{4.1.8}$$

Firstly, note that the optimal distance for K_2=K_2^* is the same in both models. Once again, this results present the optimal solution without considering the effect of uncertainty or flexibility to decide the timing. The distance is still negatively affected by the capability level of the firm, and by θ_c and positively by θ_{op}. When it comes to capital the firm will invest a multiple of its initial investment. Firms with higher capabilities will make bigger investments then those with smaller capabilities in the same conditions. Curiously, higher opportunities, ceteris paribus, lead to smaller investments, has firms can take advantage of the opportunities while trying to minimize the costs due to θ_c. θ_c on the other hand is positively related to investment size.

In sum, the effect on distance is far different from that on capital. An increase in X, or θ_c, leads to bigger, closer investments. Higher θ_{op} leads to smaller, further away investments.

We obtain the value of the investment option in an analogous procedure to what we have done above, and obtain:

$$F(X, d^*, K_2{}^*) = \begin{cases} A\left(\frac{X}{X^*}\right)^{\beta}, & \text{for } X < X^* \\ A & \text{for } X > X^* \end{cases} \tag{4.1.9}$$

Where A is the investment payoff at the optimal moment and is given by:

$$A = (X^* + d^*\theta_{op})(1-d^*)K_2{}^* + \theta_c(1-d^*)(K_1 + K_2{}^*)\frac{K_2{}^*}{K_1} - K_2{}^* \tag{4.1.10}$$

Proposition 4.1.1 *The optimal timing (capability level) to invest* [1] $K_2{}^*$*, at* d^* *is given by:*

$$X^*(K_2{}^*, d^*) = \frac{\beta(-(-2+\beta)(\theta_c+\theta_{op}) + \sqrt{4\ (-3+\beta)(-1+\beta)\theta_{op} + (\theta_c+\ \theta_{op})^2})}{(-3+\beta)(-1+\beta)} \tag{4.1.11}$$

The optimal timing follows similar behavior as the previous model, increasing with uncertainty, and decreasing with opportunities and synergies. Firm, and investment size no longer influence the trigger.

Proposition 4.1.2 *The optimal distance is given by*

$$d^* = \frac{-\theta_c - 5\theta_{op} + \frac{\beta(-(-2+\beta)(\theta_c+\theta_{op}) + \sqrt{4(-3+\beta)(-1+\beta)\theta_{op} + (\theta_c+\ \theta_{op})^2})}{(-3+\beta)(-1+\beta)} + C}{6\theta_{op}} \tag{4.1.12}$$

with:

$$C = \frac{\sqrt{[12\theta_{op} + (3\theta_c + 3\theta_{op} - 2\beta(\theta_c+\theta_{op}) + \beta\sqrt{4(-3+\beta)(-1+\beta)\theta_{op} + (\theta_c+\ \theta_{op})^2})^2}}{(3-4\beta+\beta^2)^2} \tag{4.1.13}$$

Once Again, and as we will see in the numerical example, the behavior is the same: uncertainty reduces distance, while synergies and opportunities are both positively associated with the optimal distance. Different sized firms will now opt to invest into the same segment (if the opportunities and synergies are perceived to be the same, which might not always be the case as they may relate to firm's capabilities and so even the same industries may present different value for different firms.) Finally,

Proposition 4.1.3 *The optimal capital investment is given by*

$$K_2{}^*(X^*, d^*) = \frac{K_1(-\frac{2(3\theta_c+3\theta_{op}-2\beta(\theta_c+\theta_{op})+\beta\sqrt{4(-3+\beta)(-1+\beta)\theta_{op}+(\theta_c+\theta_{op})^2})}{(-3+\beta)(-1+\beta)} + C)}{3\theta_c} \tag{4.1.14}$$

The optimal capital investment is a multiplier of the firm size, and is increasing with uncertainty, as in other similar literature (Huberts et al. (2015)). The optimal capacity is increasing with synergies, but decreasing with the opportunities as previously mentioned, (analogous to what is observed in (Hund et al., 2010)).

[1] There are other values for X, which satisfy the conditions, but it does not produce valid results, i.e. where $0 \leq d^* \leq 1$, $X^* \in \mathbb{R}^+$, $0 \leq K_2^*$ and a positive $V(X^*, d^*)$

4.2 Numerical Example

Consider the same base parameters, previously presented in Table 3.1 Distance and the trigger are both influenced in similar ways to the previous model, with the main differences being that now opportunities, synergies and uncertainty have a stronger effect, and firm size is no longer a determinant of investment, since for firms which only differ in size, both decisions will be unchanged. The size of the company will only affect the amount being invested, as firms which only differ in size will invest an equal percentage of their already existing investment (but different absolute values), at the same moment and distance. This is due to the flexibility of choosing investment size. So we focus on the capital decision.

Firms will invest up to the point where their marginal gain from an additional infinitesimal unit of investment is 0. As an increase in θ_{op} increases the (marginally constant) gains of K_2, one would expect that the optimal investment would increase, as the firm can invest up to higher marginal costs (since costs are increasing in K_2). However, the effect we observe is actually the opposite of this, as can be seen in figure 4.1.

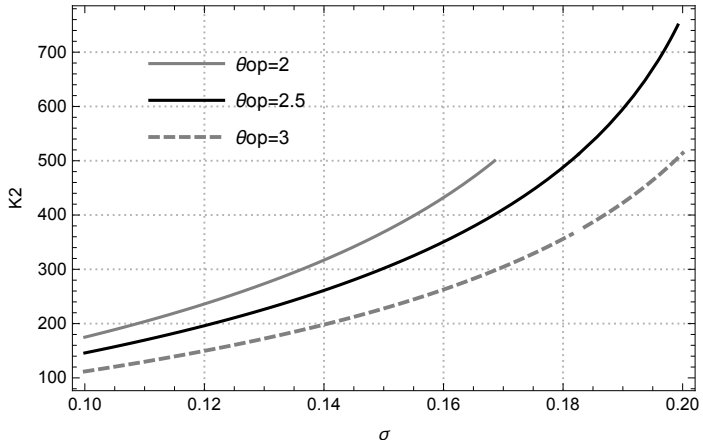


Figure 4.1: Capital, opportunities and uncertainty

This is because there are also indirect effects of the changes in the optimal trigger and distance. An increase of opportunities, lead to an increase of the optimal distance, which actually should increase the optimal K_2 being invested (as the marginal gains increase). However, the indirect effects of opportunities due to the trigger, dominates this effect, and actually leads to a much earlier and smaller investment. In order to visualize this, for different opportunity levels, we multiply the optimal investment size by the stochastic discount factor, ${K_2}^*(\frac{X}{X^*})^\beta$,to have a comparable "present value" of investment, which should control the effects of the changes in the trigger.This is shown in Figure 4.2, and it is visible the effect of opportunities on the stochastically discounted amount invested is actually significantly positive, due to the combined previous effects mentioned.

An increase in synergies, will lead to a decreased marginal cost which allows the firm to invest additional units of capital profitably, as can be seen in Figure 4.3 (this effect is reinforced in terms of the stochastically discounted value).

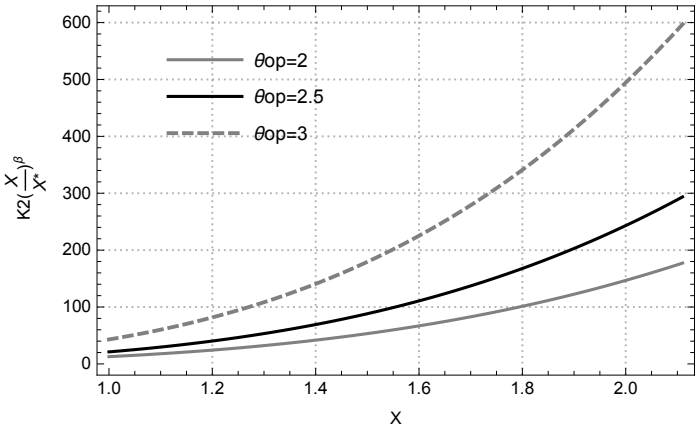


Figure 4.2: Stochastically discounted value of Investment and Opportunities

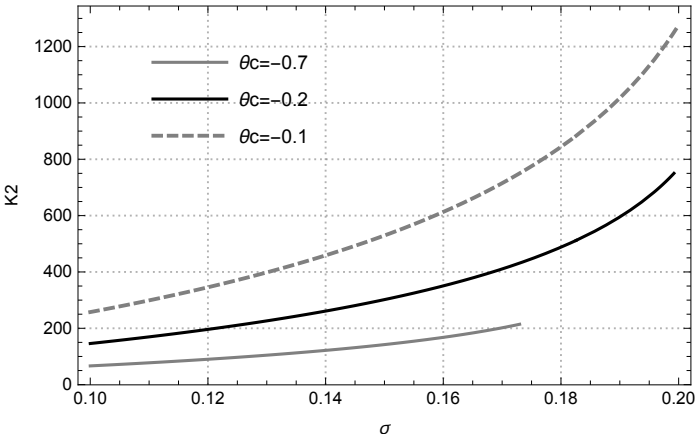


Figure 4.3: Capital, synergies and uncertainty

From the previous figures, we can also infer the positive relationship between uncertainty and capital investment. This is due to the fact, that under more uncertainty, the option to invest is more valuable, and so firms will choose to delay investment. Using a similar procedure as before, we can see that the effect on the stochastically discounted value of investment is actually negative. This is caused by the changes in distance: lower uncertainty leads to higher optimal distance investments, which mean the firms can benefit more from opportunities due to changes in $\theta_{op}(1-d)d$ (with distance below 0.5), and simultaneously have lower costs, because of the decrease in the $(1-d)\theta_c$ component, which should lead to larger investments. This is exactly what happens in figure 4.4

Finally, and to summarize we can analyze the value of decision to diversify and on the capital amount decision (When it comes to timing, it is a well established subject, investing before the optimal timing, destroys the value of the option to wait at that moment.)

For example, at the optimal trigger, and investing the optimal amount, what is the value of the *where* decision. We calculate the value for the different decisions and divide by the value created investing the optimal distance. At optimal distance, this value is obviously 1. We can see there are significant differences between decisions,

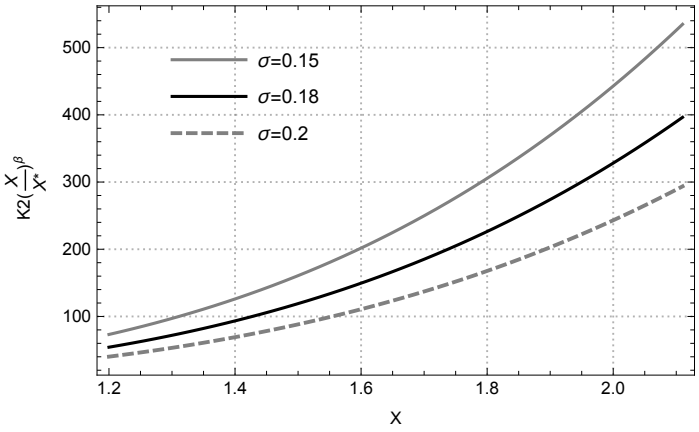


Figure 4.4: Stochastically discounted value of Investment and Uncertainty

and diversifying can in this case create almost 40% value in comparison with being focused, i.e. invested at 0.

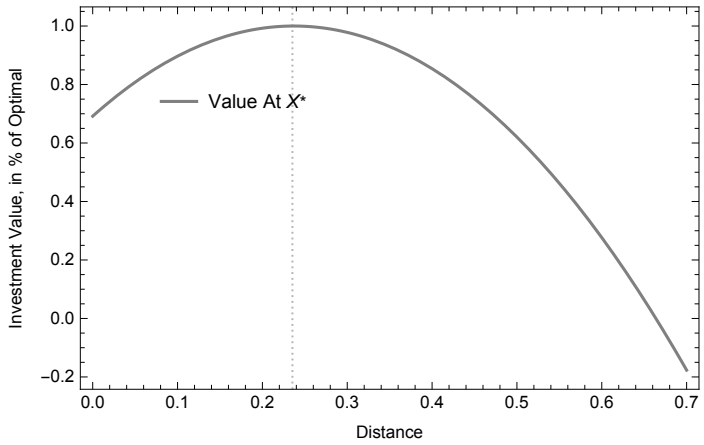


Figure 4.5: Value of deciding where to invest

The decision on how much to invest, is particularly important, as it is a center issue for the Agency and Internal Capital Markets views. We calculate the value at the optimal moment of investment, at the optimal distance, for every K_2 and divide te by the value for the optimal K_2. (Note that calculating this ratio allows for comparison, as it is the same than multiplying by any $\frac{X}{X*}^{\beta}$ for each K_2 , i.e. discounting the value stochastically as (Dixit et al., 1994) suggest. And dividing by the also discounted value for the optimal K_2. This presentation as the advantage of being independent of the selection of X, as long as X is below the exercise of the option).

From Figure 4.6 we can analyze two things, when it comes to situations where there are negative synergies: firstly in the left hand sign of the graph, even if managers act optimally, if they are restricted on capital they will create less value than if they could invest the optimal. Furthermore, given the relationship K_2 to d identified in figure **??**, they will diversify further away, meaning they will benefit more from diversification if they evolve to be less capable, and less if they are more, when comparing to the optimal scenario. Second, and perhaps the more relevant, is that the

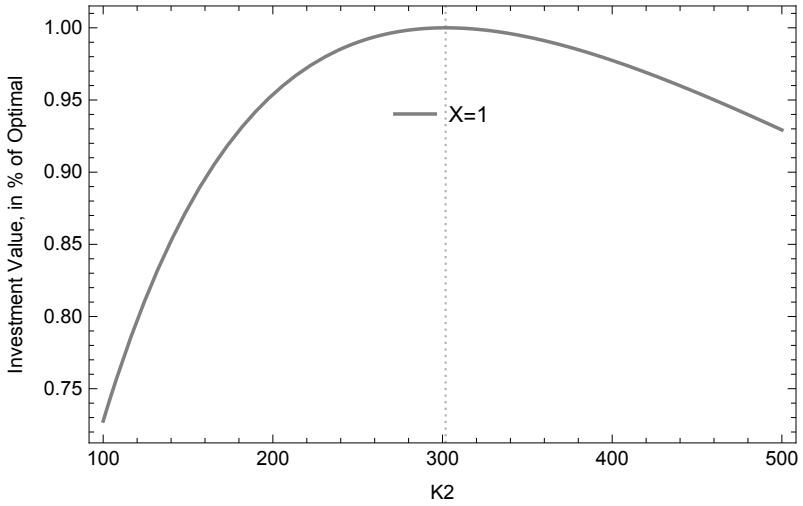


Figure 4.6: Value of Capacity decision

same happens if the firm invests a higher than optimal amount: the firm generates less value in absolute terms, even when it behaves optimally. While the slope is less accentuated for investments higher than the optimal, which could seem less dangerous, one must keep in mind that not only the total value is decreasing, the amount of capital invested is increasing so the rate of return is decreasing significantly. So if for some reason, such as empire building, managers opt to invest as high amount as possible, rather than just the optimal amount, they will be destroying significant shareholder value.

4.3 Overconfidence

The framing of our model can be useful to analyze not only the causes and consequences of diversification, but also be used to analyze and incorporate dynamic capabilities (just as an example, we could capture a higher capacity for sensing opportunities, leading to higher θ_{op}, or a higher capability to relocate translating in changing $(1-d)$ component of the payoff, into $(1-\phi d)$, with $0 < \phi \leq 1$ translating smaller losses from shifting industry, and exploit the possible effects on these decisions) and behavorial biases. As an example, we will look at overconfidence(OC). Overconfidence has been studied from as far back as the 1960's in psychology, and can be simply defined as an unwarranted belief in the correctness of ones answers Koriat et al. (1980). The relationship between overconfidence and corporate diversification, has been explored as far back as Roll (1986), who looks at mergers and acquisitions, and posits that managers of acquiror firms overestimate the value of targets, which would lead to targets experiencing higher gains than acquirors. However, they didn't find empirical evidence to be conclusive on whether this is true. Malmendier & Tate (2008) tested for this hypothesis, based on their measure of overconfidence, and found that a) Over-confident CEOs are more likely of making an acquisition, b) that Overconfident CEOs are statistically significantly more likely to do diversifying mergers (different Fama 48-Industries) but not intra-industry acquisitions, and that c) market reactions are significantly more negative for acquisitions

of overconfident managers. Andreou et al. (2017) also present a theoretical model that links CEO overconfidence and diversification, and empirically find diversified firms run by overconfident CEOs experience a value loss compared to those run by non-overconfident managers.

Adhering to the view of overconfidence as mis-calibration or unrealistic optimism (Skala (2008)), our model presents an interesting basis to theorize on the effect of overconfidence on corporate diversification, since its factors allow us to distinguish different types of overconfidence with different consequences. In the model's language, overconfidence can be translated in (at least) 4 different ways: managers may be overconfidence about their current capability level (X), on the future evolution of their capabilities (α), on the opportunity gains of diversification (θ_{op}) or on the coordination costs of diversification (θ_c), which will have a different impact on the decisions made by the firm.

Consider our base case parameters, in Table 3.1 we calculate how much does overconfidence affect the decisions [2] made by firms, and the results are presented in the Table 4.1:

Type OC	K_2	d	X^*	Value at $X = 1.5$
No OC	301.81	0.235	2.13	40.49
X^o	301.81	0.235	1.93	38.64
α^o	485.89	0.144	2.95	37.30
${\theta_{op}}^o$	227.80	0.342	1.61	33.28
${\theta_c}^o$	358.61	0.242	2.02	37.06
${\theta_c}^o$ and ${\theta_{op}}^o$	266.86	0.347	18.59	18.41

Table 4.1: Overconfidence

The simplest case is the one where managers are overconfident about their current abilities X. In this case, the decisions are unchanged, but the manager invests too soon and loses the option value resulting in the value loss in the table. When managers overestimate α, it means they expect their relative capabilities to increase more then reality. Overestimating α means underestimating the β, which leads to delayed investment, and a much smaller optimal distance. The effect of delayed investment dominates the effect on capital, and so the firm will invest a higher capital amount. When it comes to opportunities, an overestimation of opportunities will lead to a reduced trigger and a higher distance, and a much smaller investment size. Overestimating θ_c (for example: underestimating coordination costs) will also reduce the trigger as is the case for opportunities. However unlike opportunities they lead to larger investments and a (slightly) higher investment distance. Finally we also observe the combine effect of overestimating opportunities and synergies, i.e. overestimating inducements by 20%. This leads to earlier, smaller investments at a much higher distance. All types of overconfidence destroy some value, and the combination of the inducements overconfidence proves to be particularly value destroying.

[2] $X^o = X + 0.02$, $\alpha^o = \alpha + 0.01$, ${\theta_{op}}^o = \theta_{op} + 0.5$, ${\theta_c}^o = \theta_c + 0.04$

We can enrich our analysis by looking at the payoff after the firm is invested (before investing, the unbiased option dominates all other investments):

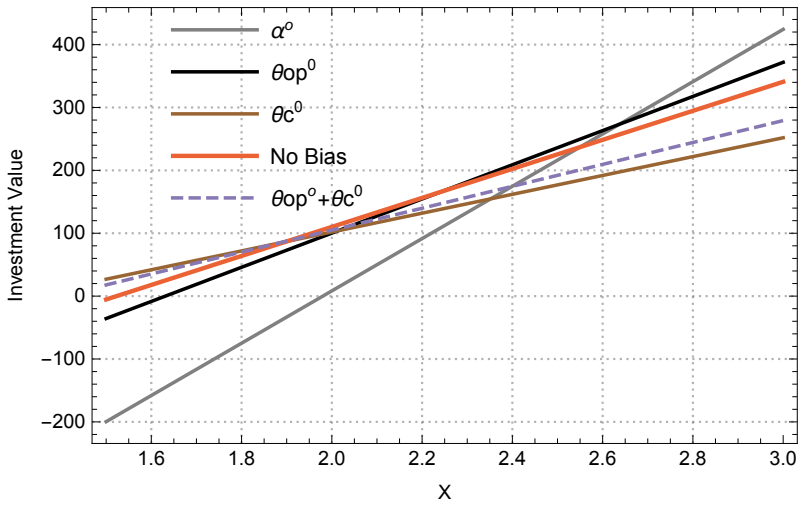


Figure 4.7: Value of Investment OC, after commitment

Overconfidence regarding θ_{op}, is in particular much less valuable, around the trigger for that decision, so the decision should be from the offset value destroying (this conclusion can lead to an empirical prediction for example that if firms are too optimistic when it comes to opportunities/growth in new markets it should generate a stronger more negative announcement) and only generates higher value than the optimal decision, in the unlikely case of a positive evolution of X. When it comes to θ_c there is little difference in value around the trigger. The decision generates a little more value if capabilities drop, but proves to be very negative if the firm's capabilities evolve positively (a possible empirical test would be: if coordination costs/synergies prove to be higher than expected, and firms increases their performance in the core segment the firm should be more likely to divest). When it comes to the combination of overconfidence, the effect of overestimating θ_c seems to dominate. Finally, when it comes to α when the option is exercised it is a value-generating exercise. The problem in this case, rests in the significant value the firm loses for lower values of X, for only exercising its option too late (and too close).

Chapter 5

Empirical Test

In this section we set to empirically test some of the main hypothesis of our model, regarding the decision over the distance of investment. From the previous model, we can set the following testable predictions:

Hypothesis 1 *Relative uncertainty over the capabilities of the firm, should be negatively correlated with investment distance, this should manifest in two ways: a) across different industries and b) across different countries*

Hypothesis 2 *Opportunities should be positively correlated with investment distance.*

And finally,

Hypothesis 3 *Synergies should be positively correlated with higher investment distance.*

5.1 Data

We use the Zephyr database to retrieve data on worldwide mergers and acquisitions, which were announced between 01/01/2010 and 01/01/2017, and are already completed. We consider only deals where the acquiror's initial stake was bellow 10% . Furthermore, we only consider cases where the Acquiror is from United States of America (US), China (CN), Australia (AU), Canada (CA), Hong Kong (HK), Japan (JP), Mexico (MX), Russian Federation (RU), Brazil (BR), Chile (CL), Colombia (CO), India (IN), Korea, Republic of (KR), Singapore (SG) or the enlarged European Union (28 countries), and obtain a sample of around 160 thousand acquisitions. We consider a firms segment to be its primary segment as obtained from Zephyr. For our analysis, we consider only the diversification acquisitions, i.e. acquisitions of firms in a different 4 digit Sic code industry, which reduces the sample to 80 392 acquisitions. Furthermore, we exclude acquisitions from firms in the financial sector (as defined in the Fama 48 industry classification), which finally reduce our sample to around 58 thousand acquisitions. We then retrieve the financial data of companies that participated in this acquisitions through the Amadeus database, from 2008 to the present. We have financial information from 41 130 different acquiring firms and 38774 targets.

5.2 Measures

Uncertainty (σ)

A key variable in our model is the uncertainty over the relative capabilities of a firm, σ. Higher uncertainty over the relative capabilities should relate to bigger changes in marginal returns of firms investments. As it is a proxy measure of relative capabilities, our proxy should relate to the likelihood a competitor can develop capabilities which undermine the value of the firm. Secondly, our proxy should relate to the manager's perception of competition, since decisions (pricing, investment, etc) will be made by managers with base on their believes: it is perceptions which will shape timing and investment decisions, while a "true" level of competition measure should have a bigger impact on the results of diversification. As a proxy of this uncertainty we adopt the measure of competition created by Li et al. (2013). Their measure is simple: to count the number of references to competition (competition, competitor, competitive, compete, competing, and plural forms) in the firms 10-K filing, removing references where not, less, few, or limited precedes the word by three or fewer words, scaled by the total number of words, as presented in Figure 5.2.1.

$$PCTCOMP = \frac{\text{Number of Competition related Words}}{\text{Total number of words}} \tag{5.2.1}$$

We denote ACComp which is the median value of PCTCOMP, for the firms in each Fama 48 industry, as a proxy of competition, and TAComp is the same value in the target firm.

Since firms should reflect on the firm's competitive position, by recommendation from the SEC (Securities and Exchange Commission), this should reflect in our measure. The basic idea is that more intense behavior from new and existing rivals diminishes a firms ability to earn profits. This measure has some advantages: it does not require identification of the source of competiton (e.g. threat of new entrants, or existing rivals, private or public, national or foreign competitors), is persistent over time and was tested empirically with good results, as returns mean revert more severely, and that returns on new investment in net operating assets (NOA) diminish faster, when management makes more references to competition, which is exactly what we would expect from higher uncertainty regarding negative capabilities. Furthermore, since we use the calculations for the Fama 48 industry classifications, this allow us to have a more enlarged set of competitors than the firm-specific, or 4 code SIC approaches (For example, Apple(SIC:8742) competes with Microsoft (SIC:7372), Samsung (Samsung Electronics SIC: 5731) ,Amazon(SIC:5961), and Google(7374) in both the hardware and software industries, which would not be considered to be even related by SIC hierarchy measures). Finally, in many cases when managers use these words they are exactly commenting on the possibility that competitors erode their profits, if they have the capabilities to develop similar products or services. Competition is usually associated with the erosion of firm's profits in the real options literature, but the association with the upside of volatility is not usual. In our case, volatility relates to relative capabilities rather than cash-flows directly. Our main argument, would be that bigger competition forces existing companies into innovating, developing new products, developing, combining and creating new

capabilities which in turn also generates larger variations in the firm value, i.e. competition breeds the use and development of capabilities(generating higher rewards for successful, and bigger losses for less successful firms). Plus, if some firms are having their abnormal profits eroded, other firms should be increasing their returns generating higher increases in value (even if divided by higher number of firms, and consumers) through increased capabilities.

Other measures of competition, have flaws or do a worst job at capturing the specific dimension we wish to capture. Cross-Elasticity based measures are successfully used but only in manufacturing industries, concentration based measures are usually built with public firm datas, which many times do not adequately translate the firms competitive environment (Ali, Klasa, and Yeung [2009] and Bens et al. (2011) and Dedman & Lennox (2009)), and capture different information.

Additionally, we proxy the uncertainty regarding capabilities in different countries, through the GCI- obtained from the World Economic Forum's global competitiveness report. We consider the average value from between 2008 and 2009, for all countries, so that all major variables are calculated in the same period, and denote it as GCIAC, the value of the GCI in the acquiror's country, and GCITA, the equivalent measure for the target's country.

Distance (d)

As previously reviewed there are many different possible measures of relatedness, we opt to use the Neffke et al. (2017) measure. As previously discussed, the core assumption of this measure, is that job changes should be easier if the production processes in the two industries draw upon more similar skills, and then quantifying the extent to which cross-industry labor flows exceed a well-defined baseline. This measure presents significant advantages over other measures of relatedness. Firstly, it extends to all firms, and not just manufacturing firms, such as the Product Space. Secondly, it is a direct measure of human capital relatedness, and so adjusts to our capabilities view of relatedness, while other approaches, capture other elements of relatedness as well, such as input or output relatedness. Thirdly, the measure seems to be relatively stable, across time and geographic decision (if people change jobs through long or small distances). Furthermore it does not assume anything about the coherence of corporate portfolios such as measures which derive such results from empirical observation (i.e. we are assuming correlations from employees individual decisions, and not firm decisions, and so firm decisions and the standard to which they are compared are independent). And finally, it is much easier to apply to a large sample, unlike survey-based measures.

Previous research as already established a negative correlation between distance and the propensity to diversify into a given sector. And the fact 3.3% of the connections between industries account for 80% of all job switches, as 56% of pairs do not observe any job switches whatsoever, reinforce our confidence in the significance of such relationships

We depart from this measure, whose result is a value between 1 and -1, symmetric in 0, we will designate by S, that translates a notion of skill relatedness, with -1 being the most distant segment, and 1 the segment itself. We create our distance measure,

to be decreasing in relatedness and bounded between 0 and 1, such that:

$$\text{Distance} = 1 - \frac{S+1}{2} \tag{5.2.2}$$

Thus our measure captures the cognitive distance between different segments.

Opportunities (θ_{op})

We proxy the opportunities in a given segment, through the median Tobin's q of firms operating in that segment in our dataset, in a given year. Our measure is the median for each segment for each year, designated by $\hat{\theta_{op}}$ of:

$$\text{Opportunities} = \frac{\text{Book value of debt+ Market Cap}}{\text{Total assets}} \tag{5.2.3}$$

The assumption is that the market will be pricing the opportunities of growth in that sector in already active firms: the higher this value the higher the expected growth in the sector (as through the median, we control for individual variation), which the firm might explore through its capabilities.

Synergies (θ_c)

We calculate synergies as the elasticity of Return on Assets, as obtained directly from Amadeus, to changes in total assets except cash. Namely we calculate:

$$\text{Synergies} = \frac{ROA_i - ROA_{i-1}}{\frac{(TA_i - Ci) - (TA_{i-1} - C_{i-1})}{TA_{i-1} - C_{i-1}}} \tag{5.2.4}$$

with TA Being total assets, and C equal to cash and equivalents. We calculate the median for each year, for each 4 digit sector in order to have a sector and year synergy measure. A high value, signifies that firms can still obtain significant increases in ROA by increasing scale (or lose significant value, by reducing size) which indicates the potential of future synergies. On the other hand, a negative value indicates, firms experience a diminished rate of return with an increase in assets which might be a sign of industry maturity or excessive coordenation costs. In addition, we create qttcneg, which classifies in 4 quartiles, from lowest values to highest, for negative values of $theta_c$ given our final model makes predictions only for negative θ_c firms.

Control Variables

Finally we collect other financial information, in order to calculate industry wide financial ratios. Namely we calculate the median of the average of the past three years in the winsorized ratio for the firms involved in transactions in a given year.

Debt and Cash serve as proxies for leverage and the amount of capital available for firms to invest. We expect larger Cash reserves to be negatively related with financial constraints. Under negative θ_c we expect this will lead to smaller distances (as K_2 increases). On the other hand debt can affect both sides: since it can help

Abbreviation	Description
DTA[1]	Total Debt over total assets
TQ [2]	Tobin's q
IFAFA	Intangible over total fixed assets
CTA	Cash over total assets
FATA	Fixed over total assets
RDOR	R&D spending over Operating Revenues
PM	Profit margin
ACDQ1	% Of industries closer than 0.25 from acquiror
ACDQ2	% Of industries between 0.25 and 0.5 from acquiror
TDQ1	Of industries closer than 0.25 from target
TDQ2	Of industries between 0.25 and 0.5 from target
TAXTA	Of industries between 0.25 and 0.5 from target
LOGTA	Of industries between 0.25 and 0.5 from target

Table 5.1: Controls

provide higher external control over managers, limiting their capacity to deviate from stakeholders interests. If that is the case, it should lead to smaller distances. However, if it is such that is constraints managers it should lead to smaller, and thus further away investments if managers act accordingly to our model.

Intangible assets and R&D investment should proxy for capabilities, and RDOR in particular can arguably proxy for the future expectations of the development of capabilities (α). Both should have a negative relationship with distance.

We include the Tobin's q as is usual in the literature, and can also be perceived as a measure of the firms capabilities and ease of access to capital, so it should be negatively correlated

Fixed Assets can in a sense proxy for capital intensity and the possibility of synergies (since higher fixed costs lead to higher possible economies of scale gains), and such should as synergies be negatively related to distance.

LOGTA is the natural log of the total assets, we should expect that has firms grow larger the potential to realize new synergies will decrease, which should lead to an increase in diversification. TAXTA is the amount of taxes paid, with an increased tax rate, firms will have increased benefits from a possible tax shield an acquisition operation may create, which should like an increase in opportunities motivate firms to move further away, by decreasing downside risk.

Finally, given some industries are better connected than others it may occur that they simply invest closer or further away due to the fact they have a higher or smaller number of firms nearby. We consider ACDQ1 and ACDQ2 as proxies to help account for the connectedness of the Acquiror, and TADQ1 and TADQ2 to that of the target firm.

5.3 Summary Statistics

Table 5.2 we present the summary statistics on the previously presented variables:

	(1)				
	count	mean	sd	min	max
Distance (d)	79,703	.408	.309	.001	1
ACcomp	108,847	.525	.093	.144	.692
GCIAC	137,252	5.21	.462	4.02	5.67
DTA	110,421	.889	.279	0	3.26
TQ	73,442	.8	.278	.161	1.72
TAcomp	118,744	.518	.092	.144	.692
IFAFA	109,723	.277	.270	0	.987
CTA	109,796	.097	.086	.0	.8651385
FATA	110,356	.441	.188	0	.982
θ_{op}	73,713	.799	.279	.161	1.72
PM	110,509	5.15	9.20	-54.43	51.58
θ_c	106,348	.084	100.75	-1714.25	1873.60
RDOR	55,638	4.71	5.69	.01	48.54
ACDQ1	136,982	.032	.013	.002	.072
ACDQ2	136,982	.08	.051	0	.33
TADQ1	135,615	.032	.013	.002	.072
TADQ2	135,615	.083	.051	0	.209
GCIAC	134,619	5.17	.487	4.02	5.67
LOGTA	114,169	10.04	1.99	2.78	16.52
TAXTA	108,623	.012	.013	-.063	.125

Table 5.2: Descriptive Statistics

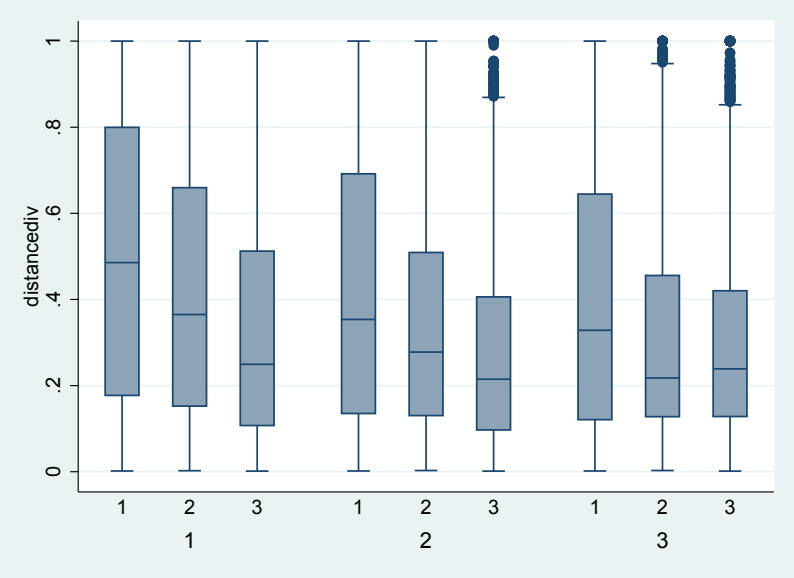


Figure 5.1: Competition and Investment Distance

The average distance at which firms diversify is 0.408, with significant standard deviation. When it comes to uncertainty, our adopted proxy ACComp varies between 0.144 and 0.692, a significant degree of variation. Target firms are in mean in slightly less competitive segments. The GCI average score is 5.21, with variation from 4 to about 5.67, since most transactions come from higher scored countries. The median industry Tobin's q measure varies signficantly between 0.16 to 1.72 along with opportunities, and when it comes to fixed assets, and the nature of those assets, results are extremely polarized, with Fixed assets representing on average around 44% of total assets, and intangibles around 28% of these values. Profit margins vary significantly as well between plus and minus 50%. There are industries where firms opt to reinvest almost none of their revenues, while others invest almost half to RD. Synergies vary between -1700 to 1873, which implies firms can create (destroy) up to around 18 monetary units for each invested unit of capital. Finally, on average, only 3% of firms are closer than 0.25, with significant variation and the same can be said for the following quartile, where some firms might have around 30% of all industries nearby while others have none. Finally, different industries vary signficantly in size and the amount of taxes paid

In figure 5.1, we represent the box-plot of the distance of investment, over different levels of competition. The graph presents us the distance at which firms diversify, divided in 9 different groups. The large division is between country competitiveness ratings (i.e. the first three left bars, are for the same country) while the second division is based on industry competitiveness. We can see there are several, significant differences, across these groups. For example, looking at the most extreme cases: The median distance for the more competitive industries, in the most competitive countries is around 0.25, while the median for less competitive is twice as much. Further more, 3 quarters of diversifications can be considered related (distance ¡0.5) for the competitive industries, while for the less competitive only around 50% of the diversification decisions are into related segments. The difference among just the

industries groups is also visibly significant [3].

5.4 Main Results

We conduct a Ordinary Least Squares (OLS) regression of distance on our explanatory variables. We used pooled OLS as date revealed itself to be non significant, if we account for other variables. We use an Ordinary Least Squares estimation as described in equation [4] 5.4.1:

$$\hat{d} = \beta_0 + \beta_1 \text{ACComp} + \beta_2 \text{TAComp} + \beta_3 \text{GCIAC} + \beta_4 \text{GCITA} + \beta_5 \hat{\theta_{op}} + \beta_6 \text{qttcneg} + \text{Controls} + \epsilon_i \tag{5.4.1}$$

In table 5.3 we have the results for our main regressions, which are generally in line with our predictions.

In all regressions, our measure of industry competition presents a highly significant (pvalue of over 0.000) negative correlation, as predicted by our model. The target competition presents similar values. Our country level measure of competition also present significant results in all models, although less significant in the end. The connectedness of firms, its position in an industry space, also proves to be significant. Especially, having more really close industries significantly decreases the expected diversification distance (keep in mind, on average this value is around 3%) and likewise for the target position in the industry network. Opportunities increase significantly the expected distance of diversification which is in line with our predictions, and are particularly significant in the second model. Synergies however, do not relate to distance as expected: an increase in synergies is associated with a reduction of the distance, which would be consistent with the model when we disregard the future evolution of capabilities in our decisions. When it comes to the control variables, once they are introduced, they seem to capture some of the effect of our models variables. In the second model, Intangibles are significantly negatively related with distance, as one would expect, if we consider these a proxy for capabilities. Cash has a highly significant effect, curiously negative effect on distance: it would be expected through our models predictions that as firms increase their capital they decrease their investment distance. These results present no real answer for the agency theory view, as we do not know if firms are on the restricted or excess investment size regarding the optimal levels: this result may coexist with diversification destroying value through overinvestment as managers pursue their

[3] More competitive firms are better connected, which could be the cause for this effect. For robustness we calculated the percentage of firms invested into every quartile of distance (distance between 0-0.25,0.25-5, etc) for each industry group. We divided this value by the percentages of industries at that range for the median firm at a competition group. Differences were all statistically significant at a 1% level. In the most competitive tercile, firms are 20% more likely to invest into the closest segment to invest at a distance between 0-0.25, and the least competitive firms are 60& more likely to diversify at a distance between 0.75-1, given that they have diversified. Results are also statistically different at a 1% level for divisions in terciles from opportunities and synergies.

[4] We have as a robustness check used robust standard errors. The main conclusions remain and are even more statistically significant, with exception to changes in significance for some control variables.

Table 5.3: Distance -Regression

	(1) Model 1	(2) Model 2	(3) Model 3
ACComp	-0.645*** (0.024)	-0.097***(0.022)	-0.185***(0.028)
TAComp	-0.125***(0.025)	-0.508***(0.021)	
ACDQ1	-2.468***(0.187)	-2.148***(0.164)	-2.058***(0.195)
ACDQ2	0.465***(0.045)	0.400**(0.036)	0.009 (0.045)
TADQ1	-2.345***(0.189)	-2.808***(0.154)	
TADQ2	0.219***(0.041)	0.344***(0.033)	
GCIAC	-0.029***(0.007)	-0.022***(0.005)	-0.016**(0.006)
GCITA	-0.021***(0.006)	-0.013***(0.005)	-0.003 (0.006)
$\hat{\theta_{op}}$	0.015*(0.007)	0.081***(0.005)	
qttcneg	-0.020***(0.002)	0.010***(0.002)	-0.004*(0.002)
TQ		0.009(0.007)	-0.010(0.009)
DTA		0.016(0.012)	-0.051***(0.015)
IFAFA		-0.078**(0.007)	0.002 (0.009)
CASHTA		-0.278***(0.036)	-0.264***(0.050)
FATA		-0.060***(0.014)	-0.082***(0.018)
PM		-0.004***(0.000)	-0.001(0.001)
RDOR		-0.002***(0.000)	-0.003***(0.000)
TAXTA		0.973*** (0.202)	0.983***(0.255)
LOGTA		0.009*** (0.001)	0.005*** (0.001)
_cons	1.151***(0.027)	0.840***(0.033)	0.687***(0.037)
N	17300	20831	14370
Adj R^2	0.1132	0.1504	0.4158
Fixed Target Effects	No	No	YES

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

interest. Debt is only statistically significant in the last model, and has a surprisingly negative effect on distance. Fixed over total assets, also have a significant relationship, as expected in accordance with the view as a proxy of synergies. Profitability reduces the average distance in the first model, through reducing financial constraints, allowing for bigger, closer investments or as a signal of higher capabilities, but is not statistically significant in the second. R&D once again behaves as expected: if firms expect their capabilities to grow further in the future they should invest at closer distances (R&D is the variable which significantly decreases the strength of the effect of our competition variables, which makes sense as it is often used to proxy competition together with advertising). Firms which pay a higher level of taxes, invest further away which is consistent with the view that tax shield represents an (financial) opportunity and reduces downsize risk. Finally firm size is positively related with distance, consistent with the view that as firms grow in size they have more limited capacity to make investments. There is no baseline comparison to understand how well our model performs through analyzing the R-Squared, as there is not, to our understanding a model which tests similar hypothesis (Tate, G. A., Yang, L. (2015). The Human Factor in Acquisitions: Cross-Industry Labor Mobility and Corporate Diversification. would be the closest, but focus exclusevely on human capital). As a baseline comparison, a regression of the same sample, using only fixed effects for target and acquiror industries presents leads us to an r-squared of around 0.47, and just fixed effects of the acquiror have an adjusted r-squared of 0.1148 so we believe that we have captured the most relevant determinants of this decision. Overall we confirm all of our main hypothesis, and most predictions over the effect of the additional control variables, which brings us close to underpinning the value drivers of these decisions, and find what motivates sector choices.

Chapter 6

Conclusions

We had set out to exploit the central issue of corporate diversification, and try to contribute to the already vast, and often contradictory, empirical evidence. We started by reviewing the literature, exposing some of the main issues such as endogeneity and the suitability and use of different measures of value and relatedness. We identified the significant contributions from different perspetives: Agency Theory, Internal capital markets and the Resource Based View, as well as focus on how external factors influence the decision making and results of diversification, and present some of the most significant models on diversification. We develop our model in a RBV framework, since it is the one which is most concerned with where investments are made. We proceed to develop a Real Options model, which allows us to account for uncertainty and flexibility, while further adding the *where* perspective to traditional RO models, which are usually focus on timing or capacity. We argue firms will consider the stand-alone value of the investment plus the value of both synergies, which are increasing in relatedness, and opportunties, which are increasing in distance up to a certain point. Our first model focuses only on timing and investment distance, and has fairly unambiguous results: higher β (lower uncertainy or α, or higher r) leads to higher optimal distance and earlier investments. Opportunities and synergies are both positively related to distance and timing. Ambiguity arises depending on the values of synergies. In the presence of positive synergies, bigger firms will invest closer than smaller firms, while the opposite happens if θ_c is negative. Once we introduce capacity, these results remain consistent. We find that in according to literature, higher uncertainty increases investment, as well as synergies, while opportunities reduce investment size. We show that, this happens mostly due to the effect off the trigger, and if we consider a stochastically discounted investment value, than opportuntites actually increase investment size as one would expect. Our analysis of the model also produces insights over why firms pursue diversification, and why it may appear to be value destroying. By comparing the value of an investment at the optimal distance and at the firm's original segments. Diversification creates values at around the optimal moment of investment, but it destroys value in case the firm's capabilities have a very positive evolution, while minimizing the value loss in case they decrease. Furthermore, we relate to the internal capital markets and agency concerns, and show the dangers of under and over investment: underinvestment leads to steeply decreased value creation (plus

the firm, will opt to be more diversified, which might be value destroying in case of a positive evolution of capabilities). Overinvestment, also destroys absolute value aggravated by the fact the firm is also investing higher amounts of value. Finally, we depart from our view of diversification as an optimal decision, and show that if investors are overconfident they will show different investment patterns, depending on how it manifests itself, namely to overestimating opportunities, underestimating coordenation costs, current capabilities or the future evolution of capabilities. All these decisions, destroy value, but differently. The combination of overestimating opportunities while underestimating coordination costs seems particularly value destroying.

Finally, we empirically test some of our main predictions, and obtain evidence which seem to suggest similar relations as predicted by our model. Further research must still establish and surpass many limitations. Empirically, the construction of better measures that allow to capture the intuition exposed by the model is a significant limitation. Survey based measures, might prove to be useful in this case. Endogeneity and correlation issues also prove significant challenges in inferring a causal relationship.

There are many avenues for future research, both empirically and theoretically. Theoretically, it might be interesting to analyze opportunities and synergies as stocasthic, or to analyze a previous decision, on an investment to reveal opportunities and synergies and the implications it might have. In addition, it would also be interesting to expand the model so that firms might have an influence on their current or future level of capabilities through investments. Furthermore, it would be interesting to analyze the implications, on the symmetrical exit decision, and how in turn that option to abandon will influence entry decisions. Finally, the model can be expanded to include the opportunity to invest in several sectors, rather than just one.

Empirically, we focused on the determinants of the diversification decision. It should be interesting to analyze the results, and effects on performance of diversification. Furthermore, the model provides the basis to analyze timing and capacity investment decisions as well. The focus, can also be shifted from M&A to greenfield investments, or to analyze different industries. Furthermore, some empirical tests may be made from the predictions on overconfidence.

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